

BIOELECTROMAGNETIC AND SUBTLE ENERGY MEDICINE

SECOND EDITION



CRC Press
Taylor & Francis Group

EDITED BY
PAUL J. ROSCH, MD

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*This book is dedicated to Marguerite, my late wife, without whose
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Section I

Preface

1 Preface: Why and How This Book Was Assembled

Paul J. Rosch*

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WHY THE NEED FOR THIS SECOND EDITION?

There have been so many dramatic advances since the publication of the first edition more than a decade ago that chapters must be updated and new ones added for it to continue to be the gold standard in this field. Certain important chapters have been reproduced because their authors are no longer with us including:

Therapeutic Applications of Nonthermal Electromagnetic Fields—W. Ross Adey
EMFs: The Interface between Matter and Function—Jacques Benveniste
Is There an Electrical Circulatory System?—Björn Nordenström
Magneto-Metabolic Therapy for Advanced Malignancy and Cardiomyopathy—Demetrio Sodi Pallares

Also reproduced are William Tiller's state of the art "Electromagnetism Versus Bioelectromagnetism" and "Subtle Energies and Their Roles in Bioelectromagnetic Phenomena" because they are so pertinent to the subtle energy focus of this volume.

SAFETY CONCERNS OVER CELL PHONES AND ELECTROMAGNETIC POLLUTION

There were topics we would have liked to discuss but could not because of space constraints and/or the inability to provide accurate and unbiased information. The most important issue was the adverse health effects of cell phones, which I tried to explain in the Preface to the first edition as follows:

Another issue that has caused wariness about bioelectromagnetic therapies are safety concerns about possible increased risk of certain malignancies and birth defects resulting from proximity to high power lines, cell phones, microwave ovens and electric blankets. It is not surprising that electromagnetic

fields, like many other therapies can be two-edged swords. For example, all the modalities we use to treat cancer, including radiation, chemotherapy and hormonal interventions can also cause cancer. Such effects may depend upon dosage, duration of exposure, genetic and other influences. It is not likely that any clear conclusion about adverse electromagnetic effects can be reached until more information has been obtained from long term studies that focus on these factors. For this reason, we have refrained from participating in this debate other than to devote a chapter on the importance of dosimetry and to emphasize that no such adverse effects have been observed or seem likely in the therapies presented in this book. Indeed, those that have been proposed and implemented by Demetrio Sodi Pallares and Björn Nordenström and confirmed by others have shown stunning success in treating various malignancies. Many of the chapters in this book are based on presentations at the annual International Congress on Stress over the past decade or so and additional information on these events can be obtained at www.stress.org

The massive Interphone study involving scientists from 16 study centers in 13 countries that began in 1999 was designed to determine whether cell phones posed any health hazards when it concluded in 2006. However, there was so much disagreement and confusion, that the final results, which were not published until 2010, shed more heat than light on the subject. The only conclusion reached after spending over \$24 million evaluating some 13,000 participants was that this rancorous controversy will continue.

There has been an explosion in cell phone sales over the past decade, and there are now over 7.3 billion, or more than the number of people on the planet. There are 100 countries where the number of cell phones exceeds the population, Russia, has 1.8 times more active cell phone accounts than people and Brazil has 1.2 times as many. In addition, there has been a steady proliferation of electromagnetic pollution from thousands of communication satellites in outer space, millions of cell phone towers and antennas emitting radio-frequency signals, WiMax towers that can cover 3000 square miles, Wi-Fi in homes and offices, and Bluetooth devices. There is also exposure to dirty electricity from transformers,

* Can be reached at stress124@optonline.net

microwave ovens and other common household appliances as well as lighting fixtures. The above issues are thoroughly and objectively discussed by leading authorities in the following chapters: “Electromagnetic Field Effects on Cells and Cancer Risks from Mobile Communication” (Igor Belyaev), “Mobile and Cordless Phone Use and Brain Tumor Risk” (Lennart Hardell and Michael Carlberg) and “Dirty Electricity” (Samuel Milham). Most of us are oblivious to this 24/7 bombardment, although it is clear that some individuals who are extremely electrosensitive have objective proof of their symptoms. In other instances, complaints of headaches, dizziness, fatigue, or difficulty sleeping, that were attributed to stress or aging, have vanished when the electromagnetic field (EMF) source has been removed. This subject is comprehensively reviewed in “Electrosensitivity: Sources, Symptoms, and Solutions” by Andrew Tressinger and Michael Bevington.

QUIS CUSTODIET IPSOS CUSTODES? (WHO IS WATCHING THE WATCHMAN?)

An equally important topic not previously addressed is the flawed regulatory system for evaluating the safety of electrical devices in the U.S. Most standards are established by the wireless industry, which is like having the fox guard the chicken coop. The only two enforceable EMF emissions standards are for microwave ovens set by the Food and Drug Administration (FDA) and for cell phones, which are established by the Federal Communications Commission (FCC). However, neither of these agencies monitor possible health effects or compliance with standards. The Russian safety limit for microwave radiation is 0.01 mW/cm², but our current limit established in 1993 is 1 mW/cm², 100 times higher. Prior to that, it was a thousand times higher! Although cell phones emit radiofrequency energy in the microwave range, there was no safety testing prior to their availability in 1983. In point of fact, cell phones are the only radiation emitting devices that have ever been sold without pre-market safety testing.

The reason for this is that the FCC contracted to have the safety standards written by an engineering society with strong ties to telecommunication and cell phone companies and there was scant or no input from physicians or health authorities. The FCC has little expertise in biology, therefore, it accepted as gospel that the only harm that could come from cell phone radiofrequencies would be from a thermal or heating effect, and as there was no evidence of this, there was no need for any objective safety testing. Nor are things likely to improve with the recent appointment of Thomas Wheeler as FCC Commissioner. Wheeler chaired the Cellular Telecommunications and Internet Association (CTIA), which represents the interests of the U.S. wireless industry and includes Verizon, AT&T, Sprint, and T-Mobile. He has numerous close industry ties, which may explain his ability to raise over \$1 million for Obama's presidential campaign.

Preserving the status quo is worth billions of dollars, and anyone who questioned the entrenched doctrine that non-thermal radiation was perfectly safe, was subjected to severe retribution. Ross Adey was the first to prove that this dogma

was erroneous, and later warned there may be no lower limit for EMF effects on health. Despite his stature in the field, he was one of these victims, as was Dr. Robert Becker, who was twice nominated for the Nobel Prize. In his 1985 *The Body Electric* and other books and papers, Becker emphasized the dangers of electropollution and particularly living near overhead high power transmission lines. As a result, his laboratory was shut down because funding suddenly disappeared and he was persecuted by powerful vested interests that he described in detail in the last chapter of *The Body Electric*, entitled “Postscript: Political Science Part One.” Nevertheless, his repeated protests were largely responsible for the New York State power line project directed by David Carpenter, which convincingly confirmed prior studies linking these high-voltage lines to childhood leukemia. Other examples of refusal to accept proof of harmful effects of cell phone and other EMF pollution by regulatory authorities can be found in the cutting edge chapters by Lennart Hardell, Igor Belayev, and Samuel Milham previously noted.

The FDA has similarly been criticized because its drug approval process is heavily influenced by powerful pharmaceutical companies, whose clout extends to Congress and academia. According to the following March 20, 2014, *Washington Post* article:

Based on critical information gathered from hundreds of leaked emails, pharmaceutical companies have doled out hundreds of thousands of dollars over the years to attend private meetings with the FDA, many of which were geared towards the regulation and approval of painkiller drugs. Drug companies would reportedly shell out upwards of \$25,000 or more per meeting to have their voices heard, a small price to pay for direct access to the \$9 billion American painkiller market.

According to reliable sources, officials from both the FDA and the U.S. National Institutes of Health (NIH) would regularly meet with pharmaceutical representatives in private to discuss regulatory protocols, co-write scientific papers and collaborate on various ways to help streamline the drug approval process. And the only parties who actually paid to attend such meetings were the drug companies, a fact that one official from the NIH expressed serious concerns about in an email, referring to the whole scheme as a “pay to play” process.

Industry employees and consultants frequently sit on advisory panels despite a ban on anyone with a conflict of interest, and in other instances, the recommendations of such panels may be rejected if they are not in favor of a manufacturer's new drug. This also applies to the Center for Devices and Radiological Health (CDRH), which has the responsibility of approving and classifying medical devices based on an objective assessment of safety and efficacy. CDRH's lack of transparency and arbitrary and capricious decisions triggered several Congressional investigations, especially after whistleblowers were fired because they documented and reported various abuses. I personally witnessed some of these at a docket hearing to reclassify cranial electrotherapy stimulation (CES) devices, which was more of a “kangaroo court.” Despite a superb safety record for over three decades and the fact that they do not require a prescription in other

countries, it was obvious that a decision had already been made, as valuable testimony and comments in support of making a change was not allowed.

Studies have shown that CES is effective for posttraumatic stress disorder (PTSD), and unlike drugs, has no adverse side effects or addictive tendencies. This is a threat to pharmaceutical companies that do not want to lose the hundreds of millions of dollars from the VA and Armed Services for products that are not only useless, but many feel may be contributing to the rising rates of suicides in veterans with PTSD not related to combat, but rather difficulty in adjusting to civilian life and dealing with bureaucratic bungling. Further details on the flawed FDA approval and classification process can be found in the chapter by Kirsch and Kirsch.

The first edition of *Bioelectromagnetic Medicine* was limited to 900 pages as any additional chapters would have necessitated two volumes of this 10-inch tall book and made its price prohibitive. This space restriction was an even more serious problem when attempting to draw up a tentative Table of Contents for this update, as deciding what to include from the 50 chapters in the first edition and select from among the many new contributions was difficult and often exasperating. I had planned to concentrate on breakthrough advances and background information that would be of particular value for clinicians and health care practitioners as opposed to basic science researchers. I used this benchmark to whittle away my list and gave the highest priority to chapters that would appeal to both groups. As indicated previously, those from Ross Adey, Jacques Benveniste, William Tiller, Björn Nordenström, and Demetrio Sodi Pallares best satisfied these criteria and they have been reproduced as they originally appeared.

I used the same standards to decide which chapters to update. Brain stimulation seemed to attract the greatest clinical interest with over 10,000 PubMed transcranial magnetic stimulation (TMS) citations and another 1000 dealing with transcranial direct current stimulation (tDCS). What was even more impressive were the 600+ registered clinical trials for TMS and 200+ for tDCS. There is also increased interest in other types of brain stimulation, such as CES, chronic deep brain stimulation, and vagal stimulation. We had devoted chapters to all of the above modalities from leading authorities, all of whom have now provided updates, which include noninvasive vagus and trigeminal nerve stimulation, noninvasive deep brain stimulation, and the latest indications for rTMS. New chapters dealing with cranial ultrasound stimulation have also been added.

ACUPUNCTURE, HOMEOPATHY AND BIOLOGICAL OR EXCLUSION ZONE (EZ) WATER

Deciding what new chapters or topics to include was even more challenging because of the embarrassment of riches from which to choose. Space constraints had precluded any discussion of acupuncture, which is widely practiced throughout the world and has persisted for thousands of years. Acupuncture is based on the belief that an intangible

and invisible energy called *Qi* (chi) circulates through the body in an orderly fashion through specific pathways (meridians) to maintain health. Illness occurs when the flow of *Qi* is blocked or there is a disturbance in the balance between its complementary *yin* and *yang* components. Similar forces are also thought to represent a “vital energy,” “life force,” or “spirit” in other cultures, such as *prana* (Hinduism), *mana* (Hawaii), *lung* Tibetan Buddhism, and *ruah* (Hebrew).

Dynamic internal and environmental energies analogous to *Qi* have also resurfaced over the centuries in Western medicine. The medieval physician and alchemist, Paracelsus postulated that a vital force called *archeus* sustains life by utilizing the *vis medicatrix naturae* (healing power of nature). Isaac Newton, the seventeenth century mathematician-philosopher borrowed some of these ideas in his concept of a mysterious cosmic “aether” that pervaded all space. Two centuries later, Franz Mesmer postulated an invisible “universal fluid” with magnetic properties that circulated throughout the body to provide energy. Disease occurred when this flow was blocked, but health could be restored by swallowing iron filings and applying magnets to the affected area. The magnets were soon discarded, as Mesmer believed the cures were due to the power of his “animal magnetism” when he touched or moved his hands over the patient. Other physicians subsequently proposed analogous healing energies, such as the Odic force of Baron Karl von Reichenbach, Oscar Brunler’s biocosmic energy, and Wilhelm Reich’s orgone. Although all of these disappeared, followers of Mesmer were responsible for developing hypnotherapy, osteopathy and chiropractic as professions, as well as Christian Science, which favors faith healing rather than drugs.

In contrast, acupuncture and traditional Chinese medicine have not only stood the test of time, but are experiencing a resurgence of interest, especially in the U.S. Some of the reasons for this are explained in “Basic Science and Evidence-Based Support for Acupuncture: The Crucial Importance and Biology of Acupuncture Points” by Richard Niemtzow, Editor of *Medical Acupuncture*. Further support comes from “Bioelectricity Circulation and Bioelectric Resonance Therapy: The Bridge Between Traditional Chinese and Western Medicine” by Yuling Wang and colleagues. Her research and therapy program had their roots in Björn Nordenström’s theory of an electrical circulatory system and his success in treating metastatic lung and other malignancies. Nordenström’s treatment protocol is still utilized for these and other disorders in China, as detailed in “Electrochemical Therapy of Tumors” by Jing-hong Li and Yuling Xin.

Homeopathy was created in 1796 by Samuel Hahnemann, a German physician, and is based on the premise that “*like cures like*,” 300 years earlier, Paracelsus wrote that “small doses of what makes a man ill also cures him” and homeopaths believe a substance that causes the symptoms of a disease in healthy people will cure sick people with similar symptoms. They accomplish this by administering highly diluted doses of anything that mimics the patient’s complaints. Homeopathy quickly spread to other countries, and by 1900, the U.S. had 22 homeopathic medical schools, 100

homeopathic hospitals and 15,000 homeopathic practitioners (one in five medical doctors). However, like many other medical practices at the time, there was little regulation, and fraud was so frequent that the teaching of homeopathy was banned following the 1910 Flexner report, and homeopathic practitioners have been accused of quackery ever since. In contrast, hundreds of millions of people in more than 80 other countries now use homeopathy. It is part of the national health system in the UK, Germany, France, India, Pakistan, Sri Lanka, Brazil, and Mexico, and it is reimbursed in Switzerland and other countries, where homeopathic physicians are licensed after several years of training and passing an examination. There is no national licensure in the U.S., states have very different certification requirements, and although the FDA recognizes homeopathic prescriptions as medicines or drugs it does not evaluate them for safety or efficacy.

One reason for this may be that any active ingredients were so diluted they could not possibly have any effect, good or bad. Many feel strongly that homeopathy should be banned, and as recently noted in one prominent U.S. journal “Homeopathy is among the worst examples of faith-based medicine. These axioms of homeopathy are not only out of line with scientific facts but also directly opposed to them. If homeopathy is correct, much of physics, chemistry, and pharmacology must be incorrect.” Last year, the new Government Chief Scientific Adviser and head of the Government Office for Science in the UK stated: “My view scientifically is absolutely clear: homeopathy is nonsense, it is non-science. My advice to ministers is clear: that there is no science in homeopathy. The most it can have is a placebo effect—it is then a political decision whether they spend money on it or not.” This may seem strange, as the Royal Family has embraced homeopathy since 1830. Prince Charles is a fervent advocate, and stated to the World Health Organization that homeopathy was “rooted in ancient traditions that intuitively understood the need to maintain balance and harmony with our minds, bodies and the natural world.”

I have gone into some detail about this since recent developments suggest that homeopathy may be effective, but for entirely different reasons. In 1988, Jacques Benveniste, a highly respected research scientist and senior director of the French medical research organization INSERM's Unit 200, reported in a study submitted to *Nature*, that white blood cells called basophils, which control the body's reaction to allergens, can be activated to produce an immune response by solutions of antibodies that have been diluted to such an extent that they contained none of these biomolecules. It appeared that the water molecules somehow retained a memory of the antibodies that they had previously been in contact with, so that a biological effect remained when the antibodies were no longer present. This “memory of water” study was published, but was prefaced with an editorial comment entitled “When to believe the unbelievable,” which emphasized, “There is no objective explanation of these observations,” and urged readers to “suspend judgement” until the results could be replicated.

Although homeopathy was not mentioned in the paper, it made international headlines, such as “Homeopathy finds scientific support,” in *Newsweek*. Several teams of investigators claimed they were unable to replicate his results, the press ridiculed Benveniste and his laboratory at INSERM was shut down. He was later able to continue his research at DigiBio, a Paris-based company funded by homeopathy supporters, and proposed that biomolecules communicate by emitting low-frequency electromagnetic signals that are detected by receptors, much like radios tuned to a specific wavelength. He claimed he was able to record these signals digitally, and that by playing them back to cells in the absence of the molecules themselves he could reproduce their biochemical effect. As he later complained to me at our annual International Congress on Stress in Switzerland, others who had reproduced all of his findings were afraid to publish their results because they would be subjected to similar retribution.

Confirmation of Benveniste's results comes from Nobel Laureate Luc Montagnier, who has now shown that when a solution of a chemical compound such as a homeopathic remedy is sequentially diluted many times, electromagnetic signals of the original substance remain in the water and retain their original effects. This is not meant to be an endorsement of homeopathy, but simply to emphasize that, “High dilutions of something are not nothing. They are water structures which mimic the original molecules.” He described Benveniste as a “modern Galileo,” as Galileo had also been persecuted and convicted of heresy for teaching that the earth revolved around the sun and was not the center of the universe. (It was not until 1992, almost 400 years later, that Galileo was officially vindicated by Pope John Paul II.) Brian Josephson, who received a Nobel Prize in Physics at age 33, agrees, noting, “Simple-minded analysis may suggest that water, being a fluid, cannot have a structure of the kind that such a picture would demand. But cases such as that of liquid crystals, which while flowing like an ordinary fluid can maintain an ordered structure over macroscopic distances, show the limitations of such ways of thinking.” He went on to describe how many scientists today suffer from “pathological disbelief; that is, they maintain an unscientific attitude that is embodied by the statement ‘even if it were true I wouldn't believe it.’”

Further support for the existence of structured or “biological” water with such properties, including the storage of energy, has been proposed and demonstrated by Mae-Wan Ho, Director of The Institute of Science and Society in London, in her chapter “Life is Water Electric.” This is explained in much more detail by Gerald Pollack, Professor of Bioengineering at the University of Washington in Seattle in “Why Biological Water Differs from H₂O and Acts Like a Battery.” Pollack has identified a fourth phase of water called exclusion zone (EZ) water, which is believed to be H₃O₂, and carries a negative charge that could explain how blood can circulate through thousands of miles of capillaries, some of which are smaller in diameter than the red blood cells that pass through them. It could also explain numerous other anomalies, such as why you sink in dry sand but can walk on wet sand near the water, or use it to build sand castles and sculptures because of its

adhesive properties. Why does water form droplets on some surfaces but not others? Why does a wave maintain its shape and gradually peter out but a tsunami wave can persist for a hundred miles or more? How can some lizards walk on water when their weight should make them sink? Gelatin desserts are mostly water, up to 99% in some cases, so why does it not leak out? Why do raindrops fall faster than they should? Why is ice usually slippery but sometimes sticky? Why does warm water freeze faster than cold water? Most things contract and become denser when they freeze. Water does the opposite, which is why ice floats on water. Yet, just prior to freezing, it expands and bursts pipes. How does water get from the roots to the top of a plant or a tall tree?

Others have long marveled at the mysteries of water. The Chinese sage Lao Tzu, called the “Father of Taoism,” described it as follows in 600 BC:

Water is fluid, soft, and yielding.

But water will wear away rock, which is rigid and cannot yield.

As a rule, whatever is fluid, soft, and yielding will overcome whatever is rigid and hard.

This is another paradox: what is soft is strong.

Leonardo da Vinci wrote, “Water is the driving force of all Nature.... In rivers, the water that you touch is the last of what has passed and the first of that which comes; so with present time.” Thus, the amount of water on earth and in our atmosphere, remains constant; there is never a drop more, never a drop less. All the water that will ever be is here, right now. Over four decades ago, Albert Szent-Györgyi, who received the Nobel Prize for discovering vitamin C, wrote:

Water, the Hub of Life.

Water is its mater and matrix, mother and medium.

Water is the most extraordinary substance!

Practically all its properties are anomalous, which enabled life to use it as building material for its machinery.

Life is water dancing to the tune of solids.

This remarkable observation is now yielding some of its secrets due to the investigations of Pollack and others. With respect to homeopathy, a comprehensive update on its present status is provided in “Memory of Water and Law of Similars: Making Sense out of Homeopathy” by Shahram Shahabi, Professor, Cellular and Molecular Research Center; Urmia University of Medical Sciences, Urmia, Iran.

WHY WAS THIS EDITION’S TITLE CHANGED AND WHAT ARE SUBTLE ENERGIES?

In many respects, this volume is a tribute to Ross Adey and Jacques Benveniste, two good friends and pioneers who are no longer with us. Ross Adey was the first to show there were “biological windows” and that nonthermal energies could have significant physiological effects.

Adey’s chapter on “Potential Therapeutic Applications of Nonthermal Electromagnetic Fields: Ensemble Organization of Cells in Tissue as a Factor in Biological Field Sensing” for the first edition was the last paper he ever wrote and it is again the lead chapter of this one because of its importance. Benveniste’s “memory of water” proposal led to a loss of funding and vicious persecution, which many believe contributed to his premature death a few months before the first edition was published. He did not live to see how he had stimulated others to confirm and extend his findings, his “A Fundamental Basis for the Effects of EMFs in Biology and Medicine: The Interface Between Matter and Function” will now be the fifth chapter. These will be followed by William Tiller’s chapters “Subtle Energies and Their Roles in Bioelectromagnetic Phenomena” and “Electromagnetism versus Bioelectromagnetism” because they provide useful background information. He has contributed two new chapters updating his research on subtle energies, one of which is entitled “The Need for Quantitative Measurement Tools to Enhance Future Research Efforts on Human Intention and Human Consciousness Effects in Multidimensional Nature.” If you think about that for a few seconds, as well as the chapters on acupuncture, homeopathy, and weird water, it is apparent that this volume deals with much more than bioelectromagnetic mechanisms. Some of the other new chapters that also led to changing the title to *Bioelectromagnetic and Subtle Energy Medicine*, include:

The Energetic Heart: Biomagnetic Communication Within and Between People—Rollin McCraty

Science of Measuring Human Energy Fields: A Revolutionary Instrument to Reveal the Energy Fields of Humans and Nature—Konstantin Korotkov

Subtle Electromagnetic Interactions in Living Things—Abraham Liboff

Holistic Electromagnetic Therapy: The Seqex Approach—Adriano Gasperi et al.

Human Brain Stimulation with Transcranial Ultrasound (TUS): Potential Applications for Mental Health—Joseph Sanguinetti et al.

Influences of Space and Terrestrial Weather on Human Physiology and Pathology—Germaine Cornelissen et al.

Medical Problems Arising from Solar Storms—Abraham Liboff

The Global Coherence Initiative: Investigating the Dynamic Relationship Between People and Earth’s Energetic Systems—Rollin McCraty and Annette Deyhle

Biophysics of Earthing (Grounding) the Human Body—James L. Oschman, Gaétan Chevalier, and Clinton Ober

The Role of the Pineal in Modulating Subtle Energies—Leonard A. Wisneski

Ion Cyclotron Resonance (Combined Magnetic Field) Applications in Medicine—Abraham R. Liboff

Tissue Resonance Interaction in the Diagnosis of Prostate and Other Tumors as well as Inflammatory Conditions—Clarbruno Vedruccio and Clara Ricci Vedruccio

MRI-Guided Focused Ultrasound: A Method for Noninvasive Surgery and Other Clinical Applications—P. Jason White and Ferenc A. Jolesz

Recent Developments in Bioelectromagnetic and Subtle Energy Medicine—James L. Oschman and Nora H. Oschman

Subtle (subtile in Old English) stems from *subtilis*, a Latin weaving term that is a contraction of the phrase *sub (beneath) and téla* (the web). Subtle now generally refers to a material, remark or something that is very faint, delicate or difficult to discern. Its use in biology and medicine was popularized by Elmer Green, who founded The International Society for the Study of Subtle Energies and Energy Medicine (ISSSEEM) in 1989. A pioneer in biofeedback therapy at the prestigious Menninger Foundation, Elmer and his wife Alyce did extensive studies of yogis and healers who could perform supernatural feats. At one of our International Congresses on Stress in Switzerland in which Elmer gave his Hans Selye Award lecture, “The Detection and Measurement Of Subtle Energies,” he demonstrated that a healer’s energy could repeatedly produce changes of 80 volts or more in EEG tracings of an invisible subject seated 10 feet away in an enclosed and shielded booth. At another Congress, *Qigong* masters raised the temperature of water, changed the taste of scotch, and repelled anyone approaching them without any physical contact by focusing their *Qi* energy.

Conventional physics maintains that all the phenomena of the universe can be explained by four forces: the strong and weak nuclear forces, electro-magnetic and gravitational forces. William Tiller disputed this in a 1993 article titled “What Are Subtle Energies,” which he defined as a “class of phenomena beyond the four fundamental energies that we already know and accept.” His major objection was that the current model did not take into account mental powers, such as the remarkable *Qigong* feats described above, and remote viewing studies showing that “people can (a) perceive and accurately describe objects placed several miles away from them, (b) be given the longitude and latitude coordinates of a location on the Earth and accurately describe the terrain of that location even though it is thousands of miles away and (c) tune in to a specific individual and view a remote locality through that individual’s eyes.”

Another example of subtle energy was the ability of certain clairvoyants to “observe the “auric” fields around patients” and describe their state of physical and mental health. These “auric” fields appear to the clairvoyant as patterns of light of different colors extending out from the body. Some clairvoyants can perceive the patterns with their eyes closed or in total darkness and as they are not composed from physical light cannot be captured with standard photography. Much of this may sound like science fiction, but Konstantin Korotkov does appear to have demonstrated how these subtle

energy or “auric” fields vary in health and disease with his gas discharge visualization (GDV) camera and electrophotonic analysis. Tiller has also shown how intentionality (the power of the mind) can influence the pH of a solution, increase ATP to speed up larval maturation, and how this mental force or energy can be transferred to a computer chip to exert the same effects at a later date and different location. Other chapters that have been updated to include advances in diagnosis and treatment include:

Repetitive Transcranial Magnetic Stimulation for Depression and Other Indications—Mark S. George et al.

The Evolution of Cranial Electrotherapy Stimulation for Anxiety, Insomnia, Depression, and Pain and Its Potential for Other Indications—Daniel L. Kirsch and Jeff Marksberry

Chronic Therapeutic Brain Stimulation: History, Current Clinical Indications, and Future Prospects—Nuprin Baxi, Ali Rezai, and Alon Y. Mogilner

Advances in Stimulation of the Vagus and Trigeminal Nerves for the Treatment of Epilepsy—Stephen C. Schachter

The Origin and Evolution of Vagal Nerve Stimulation: Implications for Understanding Brain Electrodynamics, Neuroendocrine Function, and Clinical Applications—Jacob Zabara

Clinical Application of Biophysical Stimulation on Bone in Europe—Matteo Cadossi et al.

Electroporation and Electrochemotherapy—Dietmar P. Rabussay

In addition to those chapters with a focus on subtle energies previously listed, other new contributions include:

Noninvasive Deep TMS Therapy for Diverse Neuropsychiatric Disorders—Yiftach Roth and Abraham Zangen

Electromagnetic Tissue Characterization in the Treatment of Breast Cancer—Dan Hashimony, Gil Cohen, and Iddo Geltner

Bioelectromagnetic Paradigm of Cancer Treatment: Oncothermia—Andras Szasz

Systemic Treatment of Cancer with Low and Safe Levels of Radiofrequency Electromagnetic Fields Amplitude-Modulated At Tumor-Specific Frequencies—Boris Pasche et al.

While the titles of all these chapters provide some clue as to their contents, this may not adequately convey their importance. For example, liver cancer (hepatocellular carcinoma) is the second leading cause of cancer deaths in men worldwide and has become the fastest rising tumor in the U.S., probably due the increase in Hepatitis C.

It is notoriously resistant to radiation and chemotherapy and has an average survival time of 3 to 6 months. The TheraBionic treatment described by Pasche et al. appears

to be a major breakthrough, as several patients lived 3 or 4 years, one was alive and well over 5 years later and another had a complete remission. Treatment is completely safe, has no side effects, and can be administered by patients at home for 1 h, three times a day, during which they can watch TV or read. It consists of administering radiofrequency waves that are specific for this tumor by means of a spatula like device that is held in the mouth like a lollipop. It can also be programmed for other malignancies, and one patient with breast cancer that had metastasized to the adrenal gland and bone, had a “complete response” after an 11-month treatment. A patient with stage IV thyroid cancer metastatic to the lungs has received continuous treatment for more than 7 years. The instrumentation is essentially similar to the Symtonic device for treating insomnia and anxiety I was involved with 30 years ago, as explained in the tribute to Ross Adey and was also described in the first edition. Because of this and subsequent developments, It seems likely that in the future, doctors will be prescribing frequencies, rather than pushing pills.

The operating room of the future may no longer feature surgery, which may be replaced by MRI guided focused ultrasound. As explained in this chapter, the acoustic energy of ultrasound waves is concentrated within a target area to deliver heat at a depth without affecting overlying skin and normal tissues. This scarless, bloodless, and painless procedure is effective for treating benign uterine fibroids, relieving bone pain due to metastatic disease and may be effective for patients with Parkinson’s disease and other movement disorders. Focused ultrasound surgery for fibroids takes 2 or 3 h, after which patients can resume normal activities without the need for hospitalization. See www.insightec.com/ExAblate-Vision.html for a compelling video of this.

A device implanted in the brain is required to achieve the benefits of deep brain stimulation in movement disorders such as Parkinson’s disease, multiple sclerosis and Tourette syndrome, as well as chronic pain, treatment resistant depression, epilepsy, and obsessive-compulsive disorder, as described in the chapter on chronic brain stimulation. (Be sure to see http://www.youtube.com/watch?v=uBh2LxTW0s0&feature=player_embedded for its amazing and life transforming effect in Parkinson’s disease). However, this is a complicated operation that is generally limited to patients who have failed to respond to medication, and determining optimal electrode placement may be difficult.

It now appears that many of these benefits can be achieved by noninvasive deep TMS (dTMS) as described in the chapter by Yiftach Roth and Abraham Zanger, who developed it. It uses special H-coils to target rTMS to deep areas of the brain without damaging intervening or surrounding healthy tissues and it was approved by the FDA in 2013 for treatment

resistant depression in adults. In the European Economic Area, dTMS has CE marking, and is currently prescribed for

- Alzheimer’s disease
- Autism
- Bipolar disorder
- Chronic pain
- Major depressive disorder
- Parkinson’s disease
- PTSD
- Smoking cessation
- Schizophrenia with auditory hallucination

Because of its versatility and safety, we may have only scratched the surface of the potential for this modality. In a study published in the March 2014 issue of the *Journal of Neuroscience*, Vanderbilt researchers reported that 20 min of dTMS resulted in an improvement in learning skills that lasted 5 h. This was accompanied by supportive EEG changes with a “success rate far better than that observed in studies of pharmaceuticals or other types of psychological therapy.” Studies are planned to determine its efficacy in ADHD. This and other very recent advances that could not be included in this volume will be discussed in the concluding Afterword chapter.

The above is an attempt to explain why and how this book was assembled and why chemotherapy and other drugs, as well as surgery and radiation, may soon be replaced by prescriptions for different frequencies. In that regard, the first noninvasive pulsed EMF therapy that was approved by the FDA was in 1979 for the treatment of bone fractures that had failed to heal for over a year. As in the Preface for the first edition, I will close with this 1992 prediction by J. Andrew L. Bassett.

In the decade to come, it is safe to predict, bioelectromagnetics will assume a therapeutic importance equal to, or greater than, that of pharmacology and surgery today. With proper interdisciplinary effort, significant inroads can be made in controlling the ravages of cancer, some forms of heart disease, arthritis, hormonal disorders, and neurological scourges such as Alzheimer’s disease, spinal cord injury, and multiple sclerosis. This prediction is not pie-in-the-sky. Pilot studies and biological mechanisms already described in primordial terms, form a rational basis for such a statement.

Bassett was one of the early advocates of the use of electromagnetic fields for uniting fractures that refused to heal. Unfortunately, he died before he could see that his prophecy would come true well ahead of schedule. This book is a tribute to him, Robert Becker, Ross Adey, Carl Blackman, Abraham Liboff, and other pioneers who recognized the vast potential of bioelectromagnetic medicine, as well as Jacques Benveniste and other contributors to this volume who have striven to put subtle energies on a similar solid scientific footing.

2 A Tribute to W. Ross Adey

A Man for All Seasons

Paul J. Rosch*

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There can be little doubt that William Ross Adey (1922–2004) was a child prodigy. He graduated from high school at age 14, by which time he had already built several large vacuum tube radios. He obtained a ham radio license a few years later, and by the age of 21 had received degrees in medicine (MB) and surgery (BS) from the University of Adelaide. After his first clinical position at Royal Adelaide Hospital in 1944, he served as Surgeon Lieutenant in the Royal Australian Navy for 2 years, during which he became fascinated by the new technology of radar and its clinical potential. He subsequently became involved in studying the function of limbic system structures and, because of his achievements, he was awarded a coveted Fellowship in 1950 to study at Oxford University to continue his research. The return trip from England to Adelaide included a stopover in Los Angeles, where several intriguing opportunities delayed him. In 1954, he was appointed Professor of Anatomy and Physiology at the University of California, Los Angeles and he joined their Brain Research Institute in 1961, where he worked with the Department of Defense on the CIA's super-secret Project Pandora to find ways that electromagnetic radiation could be used for mind control. In 1965, he was named Director of their new Space Biology Laboratory.

The projects his teams worked on during this period were related to brain activity of service personnel, with a focus on the effects of pulsed extremely low frequency (ELF) radiation. It included developing biotelemetry techniques that allowed electroencephalography (EEG) recordings to be done on NASA astronauts in space. In that regard, Ross made numerous contributions to all phases of EEG, from the design of surface and invasive electrodes to signal analysis. He was the first to use ordinary digital computers in EEG analysis to produce brain maps of electrical activity and assembled the first library of these maps. In the mid-1970s, he established a new laboratory at the VA Hospital in Loma Linda, CA, where, along with Suzanne Bawin, he first demonstrated the nonthermal effects of ELF-modulated radio frequency signals by showing that they caused the release of calcium ions from nerve cells. He subsequently carried out studies on the

role of ELF's in the promotion of cancer and warned about the potential cancer risks from exposure to cell phone and microwave radiation.

My interest in cranioelectrical stimulation and electromagnetic therapies was kindled in 1983 when I was asked to evaluate the use of the Symtonic low energy emission therapy (LEET) device for the treatment of insomnia and anxiety that had been developed by Swiss scientists. At the time, I was a consultant to the Biotonus Clinic in Montreux Switzerland, whose Director, Claude Rossell, MD, PhD, was involved in clinical trials that appeared to confirm claims for efficacy and safety. I had been somewhat skeptical, as there was no apparent rationale or mechanism of action to support these assertions. I was invited to participate in a weeklong conference titled "Electromagnetic Fields and Neurobehavioral Function" held on August 19–23, 1984. It was conducted in a former monastery in Priorij Corsendonck, a remote and secluded area of Belgium, and as there were no nearby attractions, the speakers ate and spent all their free time at the site. That was where and how I first met and developed a lifelong and close friendship with Ross Adey, as much of our spare time was passed in discussing mutual interests and the presentations of the 20 participants.

I was aware of his prior studies of the effect of weak electromagnetic fields on behavior in animals and his conviction that this could have important clinical implications. When I asked about this, he explained that he had implanted transmitters in the brains of cats and chimpanzees that sent signals to a receiver that displayed varied electrical activity patterns. Based on this information, he could send back specific radiofrequency signals that allowed him to control the animal's behavior to conform to different patterns. He also told me about the research of Dr. Jose Delgado, a Yale neurophysiologist, who had implanted tiny wires and electrodes in different parts of the brain and then stimulated them to see what emotional or physical changes occurred. His goal was to change a patient's mood, so that those who were depressed perked up, and anxious ones were calmed down. He later developed his "stimoceiver;" quarter size chips that could be activated by remote control after being implanted in the brain. He experimented on monkeys and cats, and, after several years, found he could make them yawn, fight,

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play, mate, and sleep by remote control. He was particularly interested in managing anger and began to study Spanish bulls by implanting stimulators and testing his equipment by making them lift their legs, turn their heads, walk in circles, or moo 50 or more times in a row. His most famous experiment that made international headlines 20 years earlier, was stepping into a bullring in Cordova, Spain, with a ferocious charging bull named Lucero, who was notorious for his temper. He had never fought a bull and had no sword for protection, but when Lucero barreled towards him, Delgado tapped his remote control and brought the animal to a screeching halt. He tapped his remote control again, and the bull began wandering around in circles, oblivious to his presence.

I also wanted to know more about the secret Pandora project involving Delgado, Adey, and other prominent neurophysiologists. Ross explained that in 1962, the CIA discovered that the U.S. embassy in Moscow was being bombarded with electromagnetic radiation of different frequencies. This was during the height of the cold war and, according to statements from Russian scientists that were subsequently obtained, its purpose was to cause blurred vision and loss of concentration. However, the compound personnel had numerous other complaints and blood tests showed a variety of strange abnormalities and unusual chromosome changes. Ambassador Stoessel suffered from headaches and bleeding from the eyes and was later diagnosed as having a rare leukemia-like blood disease. According to one account, long-term follow-up revealed that a third of the compound's employees eventually developed some type of malignancy. It was subsequently discovered that a radio transmitter on the roof was inducing high frequency signals well above the U.S. safety standards through the phones in the political section, as well as in the lines to Stoessel's office.

The purpose of the Pandora Project, which was conducted in the late 1960s and early 1970s, was to gather data on this Russian experiment and to determine if the U.S. could develop something superior that might have applications for the military. That was all he could tell me because Pandora was still top secret. However, it was clear that Ross was selected to participate in this, as he had previously proposed that if a radio signal was made to simulate a brain wave, it could influence behavior. He was later able to demonstrate that you could make the brain wave pattern follow the modulation on the radio signal in cats. He told me that the Russians were well ahead of everyone else with respect to using radio-frequency signals as medical tools. As far back as the 1940s, researchers in Soviet Armenia had developed the prototype of an instrument for "the treatment of neuropsychic and somatic disorders, such as neuroses, psychoses, insomnia, hypertension, stammering, asthma, and asthenic and reactive disturbances." This later culminated in the LIDA device, which used pulsed light and sound waves in addition to electromagnetic radiation to treat insomnia and depression. The Russians kept it under wraps, and the only U.S. scientist who had studied it was Ross Adey, as the CIA had purchased one for him from a Canadian front.

He began testing it around 1980 and, according to press reports, said it acted like Valium, and that when he put a cat in a box and turned on the LIDA, "Within a matter of two or three minutes it is sitting there very quietly and stays almost as though it were transfixed." The Russians also pioneered the use of cranioelectrical stimulation (CES) to treat insomnia, which, when introduced into the U.S., was originally called "electrosleep." LIDA could also have this effect and there was a photo of an entire auditorium full of sleeping Russians with the LIDA on the podium. He said that a few years earlier, while he was testing the device, an electrician who was watching asked where he got the "North Korean brain washing machine." Ross told him it was a Russian medical device and the electrician explained that he had been brainwashed by a similar instrument when he was in a POW camp decades earlier. Electrodes were placed on his head and question and answers were repeatedly read to him. He said he felt like he was in a dream and when the Red Cross later came and asked questions, he replied with what had been read to him and seemed to have no control over the answers. Other prisoners had also made similar claims of having been brainwashed.

In addition, we also discussed the presentations of the other speakers, as well as our own. He dealt with the role of the cell membrane in the detection and transductive coupling of oscillating electromagnetic fields, and delineating the activation of intracellular systems responsible for amplifying these signals.¹ It seemed far removed from my assignment, the concluding talk, in which I was asked to summarize previous speakers' findings with respect to their future implications for clinical medicine. The title that I had been assigned was "Electromagnetic Waves and Neurobehavioral Function: Comments From Clinical Medicine."² Although I had made copious notes, I thought it would be an ideal opportunity to discuss the Symtonic device before this distinguished audience. Ross urged me to do so, as did Carl Blackman, another pioneer in ELF stimulation from the EPA, Yale's Eleanor Adair, an authority on thermoregulation and microwaves and John Monahan, head of the FDA's CDRH division.

I felt it would be best for Claude Rossell to present this in case there were technical questions I could not answer, as well as to demonstrate the device. After discussing this with the sponsors, who agreed, I called Claude and he immediately arranged to join us for the final day of the conference to report on his latest findings. His presentation was very stimulating, as he had some new supportive data and Ross was particularly intrigued with Symtonic's novel delivery system and its ease of administration and asked several stimulating and critical questions. Dr. Rossell was impressed with his extensive knowledge and experience with both the basic science and clinical aspects of extremely low frequency fields, and we both felt he would be a valuable consultant to suggest studies on other stress related disorders. Claude subsequently proposed organizing an annual International Montreux Congress on Stress under the aegis of the American Institute of Stress that would include sessions dealing with relevant advances in "electromedicine." I was given carte blanche to select the speakers and topics, and the Congress would be

conducted at the five star Grand Excelsior Hotel adjacent to the Biotonus Clinic, which funded speakers' accommodations, airfare, and honoraria.

Our First Congress was in 1988; Ross was the recipient of our annual Hans Selye Award at our 1999 Congress, and an active participant in all of them. We were constantly amazed at his wide range of knowledge, not only in his area of expertise, but also in all aspects of clinical medicine and esoteric subjects, such as *Qigong* healing and the prowess of Indian fakirs. He was equally knowledgeable about current events and social issues, such as the growing immigration problem in California, and, although always polite, could be adamant in his opinions and a formidable opponent in a debate. His presentations were eloquent and although a picture may be worth a thousand words, few could improve on his "whispering among cells" to describe the effects of nonthermal electromagnetic fields on communication between brain neurons. My wife and I spent time with him visiting Switzerland after some of our Congresses and were impressed with his knowledge of Shakespeare, which he could quote at length, as well as his humility and kindness. When he learned that we planned to visit his beloved Australia, he prepared a list of sites to visit, sent us books and articles, and arranged for his friends at various locations to escort us around.

As I noted in the *Lancet* obituary that I was asked to contribute to, of all his more than 400 publications, he will be remembered mostly for discovering what has been called the "Adey window," which "describes the confined parameters

under which a very weak nonthermal electromagnetic signal has a physiological effect." Not included was my comment that Ross Adey was a true Renaissance figure in medicine, whose likes will not be seen soon again. He was "A man for all seasons." This was the expression the great German humanist Desiderius Erasmus used to describe his good friend, Sir Thomas More. Erasmus was alluding to *Corinthians* 9:22, "I become all things to all men, that I might save all" when he wrote the following in Latin, more than 500 years ago,

More is a man of an angel's wit and singular learning. He is a man of many excellent virtues; I know not his fellow. For where is the man (in whom is so many goodly virtues) of that gentleness, lowliness, and affability, and as time requires, a man of marvelous mirth and pastimes and sometime of steadfast gravity—it would be hard to find anyone who was more truly a man for all seasons and all men. (*omnibus omnium horarum homo*).

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Section II

Chapters Reproduced from the First Edition

3 Preface from the First Edition

Paul J. Rosch*

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PREFACE FROM THE FIRST EDITION

A BRIEF HISTORICAL PERSPECTIVE

According to *The Yellow Emperor's Canon of Internal Medicine*, our oldest extant medical text, magnetic stones (lodestones) applied to acupuncture points were used to relieve pain and other complaints 40 centuries ago. The *Vedas*, religious scriptures of the Hindus also believed to be several thousand years old, similarly allude to the therapeutic powers of *ashmana* and *siktavati* (instruments of stone). The Greeks referred to these as *lapus-vivas* (live-stones) and Hippocrates purportedly used them to cure sterility. Egyptian physicians ascribed a variety of benefits to magnetic stones, as did early Buddhists. Tibetan monks still place bar magnets on the skull to improve the concentration and learning ability of novitiates in accordance with an age-old protocol.

In the early 1500s, the Swiss physician and alchemist Paracelsus became convinced that magnetism could restore the body's vitality and used magnets to promote healing and treat epilepsy, diarrhea, and certain types of hemorrhage. Lodestones were ground up to make powders that could be applied as magnetic salves or ingested to provide energy and stop bleeding. Such practices became very popular but they were debunked in 1600 by William Gilbert in *De Magnete*. By the middle 1700s, more powerful, carbon-steel magnets had become available in Europe and there was heightened interest in their curative powers. Franz Anton Mesmer quickly became famous for his miraculous cures of everything from deafness to paralysis. In his 1775 report *On the Medicinal Uses of the Magnet*, he vividly described how he had restored health to a patient with uncontrollable seizures and numerous other nervous system complaints by feeding her iron filings and applying specially shaped magnets over affected organs. He later claimed that the healing force actually resided in his own "animal magnetism" (*magnetisomum animale*). This was hailed as a new force analogous to Newton's gravity, and people from all over Europe waited in long lines to be treated in his Paris salon. French

physicians considered him a fraud and convinced Louis XVI to establish an unbiased commission consisting of Benjamin Franklin, Antoine Lavoisier, and Dr. J.I. Guillotin to investigate Mesmer's claims. They observed blindfolded patients who were exposed to very strong magnets and asked to describe their responses when fake objects were unknowingly substituted. The commission concluded in 1784 that magnetic healing was entirely due to the belief of the patient (placebo effect) and the power of suggestion (hypnosis). We still refer to hypnotism as "mesmerism."

Although Mesmer was thoroughly discredited, magnet therapy flourished in the United States and permanent magnet sales soared after the Civil War, particularly in the newly industrialized western farm belts. Magnets, magnetic salves, and liniments were dispensed by traveling magnetic healers and were readily available at food and grain stores. By the turn of the century, mail-order catalogs offered magnetic soles for boots (profitable at 18 cents a pair) as well as magnetic rings, belts, caps, girdles, and other apparel that purportedly could cure anything from menstrual cramps to baldness and impotence. The king of magnetic healers was Dr. C.J. Thacher, whose Chicago's Magnetic Company in the 1920s promised "health without the use of medicine." His mail-order pamphlet explained that the energy responsible for life comes from the magnetic force of the sun, which is conducted through the rich iron content of the blood. Disease resulted when stressful lifestyles and environmental factors interfered with these healing forces. However, "magnetism properly applied will cure every curable disease no matter what the cause." The most efficient way to expedite this alleged ability of iron in the blood to transmit healing magnetic energy was to wear magnetic clothing, and almost every conceivable garment was available. A complete costume, which promised "full and complete protection of all the vital organs of the body," contained 700 magnets!

It is not clear when electricity was first used to treat illness but electric catfish native to the Nile are portrayed in Egyptian murals several thousand years old that suggest medical applications. The Roman physician Scribonius Largus used a live torpedo fish to treat a patient with gout and wrote in 46 AD that headaches and other pains could be

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cured by standing in shallow water near these electric fish. The powerful South American electric eel was introduced to Europe in 1750, and people flocked to be treated with its “natural electricity.” Around the same time, the invention of the Leyden jar had dramatically demonstrated the ability of a stored electrical charge to produce muscle contractions and shocks. The publication of Mary Shelley’s *Frankenstein* in 1818 stimulated interest in electricity as the source of life. As Galvani had shown that limbs or other body parts would jump when electrical shocks were administered to animal and human cadavers, it was believed that electricity could bring the dead to life. Various “reanimation” chairs and devices were constructed, some of which may possibly have acted as pacemakers or defibrillators in the rare cases that responded. An induction coil with sponge-tipped electrodes was used in 1853 to successfully treat abnormal heart rhythms and angina. Over the next few decades, as batteries were progressively improved and electricity from generating stations became available, all sorts of “medical coils” were developed with diverse curative claims.

By the early 1900s, electrotherapeutics was viewed as a legitimate medical specialty much like the growing fields of radiology and radium therapy, and medical textbooks devoted chapters to the use of magnetism and electricity. Devices were devised to diagnose and treat anemia, hysteria, convulsions, insomnia, migraine, neuralgia, arthritis, fatigue, and all types of pain. Some were based on the proposition that each organ or individual was “tuned” to a specific electromagnetic wavelength whose application could energize or rejuvenate them. The most popular were the dynamizer and oscilloclast devised by Albert Abrams, a physician who was described by the American Medical Association in 1925 as the “dean of twentieth century charlatans.” The dynamizer was said to be so sensitive it could not only diagnose a disease from a drop of blood, photograph, or handwriting sample but also pinpoint its location in the body. The oscilloclast was then simply set to the vibratory rate of the disease to be treated and the treatment was likened to shattering a wineglass with sound vibrations. A decade later, Wilhelm Reich claimed he had discovered a universal cosmic and biological energy called orgone that permeated the universe. He constructed an orgone accumulator box he claimed could collect and accumulate orgone obtained from the atmosphere. Sitting in the accumulator would not only restore and promote health and vitality but was an effective treatment for cancer. The Food and Drug Administration (FDA) sued and convicted him for fraud, and the court ordered his books and research burned and his equipment destroyed. Although Abrams died in prison in 1957, he still has fervent followers who believe in his theories and devices, judging from various websites. Other contraptions made similar extravagant but worthless claims, so it is not surprising that all bioelectromagnetic approaches came to be regarded as fraudulent. A more detailed discussion of the above is available elsewhere.¹

Unfortunately, this dismissed legitimate research, and it is not unlikely that in some instances the baby was thrown out with the bathwater. One example may be the work of Harold

Saxton Burr, whose theory of “L fields” of life showed great potential for the diagnosis of cancer and the treatment of various disorders. His research results using the comparatively crude devices available over a half century ago are now being intensively reinvestigated and confirmed with more sophisticated technology. In recent years, magnetic resonance imaging (MRI) and positive emission tomography (PET scanning) have emerged as superior diagnostic aids. Cardiac pacemakers, defibrillators, and other implantable electromedical devices have saved countless lives and eased the suffering of patients with Parkinson’s disease and other debilitating disorders. The FDA has also approved specific electromagnetic devices to promote the healing of bone fractures that have failed to unite despite other interventions; this procedure has proven successful and safe in hundreds of thousands of patients over the past few decades. More recently, electromagnetic therapies for the treatment of urinary incontinence, sports injuries, and liver and kidney tumors have also been approved. Other approaches, for the treatment of osteoarthritis, pain, tinnitus, and other indications, have satisfied criteria for efficacy and safety that have led to their approval in European and other countries and that may allow them to be available in the United States under the “globalization” and “harmonization” provisions of the 1997 FDA Modernization Act.

WHY AND HOW THIS BOOK WAS WRITTEN

Permanent magnet and electromagnetic therapies are now riding the crest of a tidal wave of interest in “alternative” and “complementary” medicine. Unfortunately, charlatans, entrepreneurs, and misguided zealots with worthless devices and unfounded claims still abound. It is essential to distinguish these from authentic approaches and products. As a result, in this book we have tried to separate the wheat from the chaff by restricting contributions to evidence-based medicine supported by references in peer reviewed publications and to provide the reader with tools and skills for evaluating the legitimacy of devices and claims. In addition to a lengthy history of quackery and fraud, another criticism that has hampered wider acceptance of bioelectromagnetic approaches is the inability to identify the mechanisms of action responsible for any benefits. We have therefore attempted to identify concepts and theories that attempt to explain the mechanisms responsible for mediating the diverse benefits of bioelectromagnetic therapies and, in some instances, how they may relate to ancient concepts of subtle energies in the body that are also found in nature. How weak environmental electromagnetic energies as well as those generated internally can produce nonthermal biological effects is not clear, as the absence of detectable heat exchange would appear to violate the laws of thermodynamics.

In addition, our current concept of how communication takes place in the body is at a chemical/molecular level as we visualize small peptide and other messengers fitting into specific receptor sites on cell walls much like keys opening certain locks. Such physical structural matching that could

occur only on a random-collision basis cannot explain the myriad instantaneous and automatic reactions such as those that occur in “fight or flight” responses to severe stress. As will be seen, there is an emerging paradigm of cellular communication at a physical/atomic level that may provide some answers and also provide insights into widely acknowledged but poorly understood phenomena, such as the placebo effect, the power of prayer and a firm faith, telepathic communication, the benefits of acupuncture, homeopathy, therapeutic touch, various bodywork and massage therapies, and Kirlian and other low-level imaging procedures.

Another issue that has caused wariness about bioelectromagnetic therapies are safety concerns about possible increased risk of certain malignancies and birth defects resulting from proximity to high power lines, cell phones, microwave ovens, and electric blankets. It is not surprising that electromagnetic fields, like many other therapies, can be two-edged swords. For example, all the modalities we use to treat cancer, including radiation, chemotherapy, and hormonal interventions, can also cause cancer. Such effects may depend on dosage, duration of exposure, and genetic and other influences. It is not likely that any clear conclusion about adverse electromagnetic effects can be reached until more information has been obtained from long-term studies that focus on these factors. For this reason, we have refrained from participating in this debate other than to devote a chapter on the importance of dosimetry and to emphasize that no such adverse effects have been observed or seem likely in the therapies presented in this book. Indeed, those that have been proposed and implemented by Demetrio Sodi Pallares and Björn Nordenström, and confirmed by others have shown stunning success in treating various malignancies. Many of the chapters in this book are based on presentations at the annual International Congress on Stress over the past decade or so, and additional information on these events can be obtained at www.stress.org.

We have also attempted in this book to trace the origin and development of various therapies, such as TENS and vagal nerve stimulation, by pioneers in the field such as Norman Shealy, Donlin Long, and Jacob Zabara. Kirk Jeffrey has contributed a similar chapter on the evolution of cardiac pacemakers. We have made a concerted effort to include prominent scientists whose research may not be well known in the United States. When initially approached to serve as editor of this book, I explained that this was not my

field of expertise and asked Marko Markov, a distinguished physicist, to serve as co-editor. He is also much more familiar with relevant advances in Eastern Europe and Russia, and I am grateful for his careful review of all chapters and for those he has attracted from these countries as well as his own contributions. I am also indebted to Russell Dekker for expediting this work so that the material would be current and important late-breaking advances could be included, such as radiofrequency coblation nucleoplasty for disc disease. I would also like to thank all the authors for their cooperation in responding so promptly to urgent requests for revisions necessary to adhere to this very accelerated publication schedule.

The above is a brief summary of why this book is needed and how it was assembled. I believe it is particularly appropriate to conclude with the following quotation.

In the decade to come, it is safe to predict, bioelectromagnetics will assume a therapeutic importance equal to, or greater than, that of pharmacology and surgery today. With proper interdisciplinary effort, significant inroads can be made in controlling the ravages of cancer, some forms of heart disease, arthritis, hormonal disorders, and neurological scourges such as Alzheimer's disease, spinal cord injury, and multiple sclerosis. This prediction is not pie-in-the-sky. Pilot studies and biological mechanisms already described in primordial terms, form a rational basis for such a statement.

J. Andrew L. Bassett
1992

Andy Bassett was one of the early advocates of the use of electromagnetic fields for uniting fractures that refused to heal. Unfortunately, he died before he could see that his prophecy would come true well ahead of schedule. In many respects, this book is a tribute to him and other pioneers such as Bob Becker, Abe Liboff, Björn Nordenström, and Ross Adey who recognized the vast potential of bioelectromagnetic medicine and have helped to put it on a solid scientific footing. I am particularly delighted that we were able to obtain contributions from most of these trailblazers.

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4 Potential Therapeutic Applications of Nonthermal Electromagnetic Fields

*Ensemble Organization of Cells in Tissue as a Factor in Biological Field Sensing**

W. Ross Adey[†]

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There are major unanswered questions about possible health risks that may arise from human exposures to various man-made electromagnetic fields where these exposures are intermittent, recurrent, and may extend over a significant portion of the lifetime of the individual. Current equilibrium thermodynamic models fail to explain an impressive spectrum of observed electromagnetic bioeffects at nonthermal exposure levels. Much of this signaling within and between cells may be mediated by free radicals of the oxygen and nitrogen species.

INTRODUCTION

In our solar system, the natural electromagnetic environment varies greatly from planet to planet. In the case of planet Earth, a semiliquid ferromagnetic core generates a major and slowly migrating *static* geomagnetic field. Concurrently, there are much weaker natural *oscillating* low frequency electromagnetic fields that arise from two major sources: in thunderstorm activity in equatorial zones of Central Africa and the Amazon basin and in lesser degree from solar magnetic storms in years of high activity in the 11-year solar sunspot cycle.

* Portions of this chapter were first published in D. Clements-Croome, ed. *Electromagnetic Environments and Safety in Buildings*. London: Spon Press; 2002.

[†] Deceased.

COMPARISON OF NATURAL AND MAN-MADE ELECTROMAGNETIC ENVIRONMENTS

All life on earth has evolved in these fields. Defining them in physical terms permits direct comparison with far stronger man-made fields that have come to dominate all civilized environments in the past century. Energy in the *oscillating* natural fields is almost entirely in the extremely low frequency (ELF) spectrum, with peaks at frequencies between 8 and 32 Hz, the Schumann resonances.¹ Their electric components are around 0.01 V/m, with magnetic fields of 1–10 nT. These natural oscillations are ducted worldwide between the earth's surface and the ionosphere at an approximate height of 250 km. With a circumference of 41,000 km, the earth may act as a cavity resonator for this ducted propagation (at the velocity of light, 300,000 km/s), behaving resonantly at a frequency around 8 Hz. Neither solar nor terrestrial sources contribute significant amounts of radiofrequency or microwave energy to the earth's biosphere, and we may contrast these weak ELF fields with the earth's much larger static geomagnetic field around 50 μ T (0.5 gauss).

The earth's *static* magnetic field at 50 μ T is 5000 times larger than the natural oscillations but still substantially less than a wide range of daily human exposures to static and oscillating fields in domestic and occupational environments.

Generation and distribution of electric power has spawned a vast and ever growing vista of new electronic devices and systems. They overwhelm the natural electromagnetic environment with more intense fields. They include oscillations far into the microwave spectrum, many octaves higher than the Schumann resonances. This growth of radio frequency (RF) and/or microwave fields is further complicated by the advent of digital communication techniques. In many applications, these microwave fields, oscillating billions of times per second, are systematically interrupted (pulsed) at low frequencies. This has raised important biological and biomedical questions, still incompletely answered, about possible tissue mechanisms in detection of amplitude- and pulse-modulation of RF and/or microwave fields.²

HISTORICAL EVIDENCE ON POSSIBLE HEALTH EFFECTS OF MAN-MADE ENVIRONMENTAL FIELDS

There are major unanswered questions about possible health risks that may arise from human exposures to various man-made electromagnetic fields where these exposures are intermittent, recurrent, and may extend over a significant portion of the lifetime of the individual. Historical correlations have been reported between growth of rural electrification in the United States and the United Kingdom and an increased incidence of childhood leukemia. A peak in childhood leukemia at ages 2 through 4 emerged *de novo* in the 1920s. Using U.S. census data for 1930, 1940, and 1950, Milham and Osslander³ concluded that the peak in the common childhood acute lymphoblastic leukemia (ALL) may be attributable to electrification.

Design of modern office buildings has led to their electrification through one or more large distribution transformers

that may be located in basement vaults, or in some cases, located on each floor of the building. Milham⁴ has examined cancer incidence in such a building over a 15-year period and found evidence for *cumulative risks*. An analysis of linear trend in cancer incidence, using average years employed as an exposure score, was positive ($p = 0.00337$), with an odds ratio of 15.1 in workers employed longer than 5 years.

In large modern offices, the electromagnetic environment has been further complicated by introduction of local area networks (LANs) for local telephonic (voice) and data transmission. Workers may be continuously exposed to fields from a plethora of sources located on each computer and on local network controllers. Their power output is typically in the low milliwatt to microwatt range—so low that significant heating of workers' tissues is improbable. Any bioeffects attributable to their operation strongly suggest *nonthermal* mechanisms of interaction, and raise further important questions about mechanisms mediating a cumulative dose from repeated, intermittent exposures, possibly over months and years. None of these studies supports tissue heating as an adequate model for bioeffects seen in a wide spectrum of laboratory experiments (see below) or in reported epidemiological findings.

The American National Standards Institute (1992) first recognized a tissue dose of 4.0 W/kg as a *thermal* (heating) tissue threshold possibly associated with adverse health effects and proposed an exposure limit in controlled environments (occupational) at 0.4 W/kg, thus creating a supposed "safety margin" of 10. For uncontrolled environments (civilian), a larger safety margin was set with a permissible exposure limit (PEL) 50 times lower at 0.08 W/kg. As actual measurement of tissue specific absorption rates under environmental conditions is not a practical technique, PELs are typically expressed as a function of *incident field power density*, the amount of energy falling on a surface per unit area, and expressed in mW/cm².

More recently, the U.S. government Interagency Radio Frequency Working Group (1999) has emphasized the need for revisions recognizing nonthermal tissue microwave sensitivities:

Studies continue to be published describing biological responses to nonthermal ELF-modulated RF radiation exposures that are not produced by CW (unmodulated) radiation. These studies have resulted in concern that exposure guidelines based on thermal effects, and using information and concepts (time-averaged dosimetry, uncertainty factors) that mask any differences between intensity-modulated RF radiation exposure and CW exposure, do not directly address public exposures, and therefore may not adequately protect the public.

INITIAL TRANSDUCTION OF IMPOSED MICROWAVE FIELDS AT NONTHERMAL ENERGY LEVELS t

Tissue components of environmental RF and microwave fields are consistent with two basic models. Sources close to the body surface produce *near-field exposures*, as with users

of mobile phones. The emitted field is magnetically coupled directly from the antenna into the tissues. At increasing distances from the source, the human body progressively takes on properties of a radio antenna, with absorption of radiated energy determined by physical dimensions of the trunk and limbs. This is a *far-field exposure*, defined as fully developed at ten or more wavelengths from the source and based on interactions with the electric component of the radiated field. Permissible exposure limits (PELs) have rested on measurement of microwave field energy absorbed as heat, expressed as the *specific absorption rate* (SAR) in W/kg.

There is an initial dichotomy in possible modes of interaction of cells in tissue with environmental microwave fields. It is principally determined by the separation of responses attributed to tissue heating from those elicited by certain fields at levels where frank heating is not the basis of an observed interaction. Their interpretation and possible significance has required caution in both biological and biophysical perspectives. Many of these biological sensitivities run counter to accepted models of physiological thresholds based in equilibrium thermodynamics of kT thermal collision energies. In a physical perspective, the search also continues for biological systems compatible with a first transductive step in a range of functionally effective vibrational and electromagnetic stimuli that are orders of magnitude weaker than kT . Aspects of these findings are reviewed in the section “The Role of Cellular Ensembles in Setting Tissue Thresholds for Intrinsic and Environmental Stimuli.” Their occurrence invites hypotheses on directions of future research.⁵

CELL MEMBRANES AS THE SITE OF INITIAL FIELD TRANSDUCTIVE COUPLING

Collective evidence points to cell membrane receptors as the probable site of first tissue interactions with both ELF and microwave fields for many neurotransmitters,⁶ hormones,^{7,8} growth-regulating enzyme expression,^{9–12} and cancer-promoting chemicals.¹³ In none of these studies does tissue heating appear involved causally in the responses.² Physicists and engineers have continued to offer microthermal, rather than athermal, models for these phenomena^{14,15} with views that exclude consideration of cooperative organization and coherent charge states. However, it is difficult to reconcile experimental evidence for factors such as modulation frequency dependence and required duration of an amplitude-modulated signal to elicit a response (*coherence time*)¹¹ with models based on the equilibrium dynamics of tissue heating.

EVIDENCE FOR THE ROLE OF FREE RADICALS IN ELECTROMAGNETIC FIELD BIOEFFECTS

Examination of vibration modes in biomolecules, or portions of these molecules,¹⁶ has suggested that resonant microwave interactions with these molecules, or with portions of their structure, is unlikely at frequencies below higher gigahertz spectral regions. This has been confirmed in studies showing

collision-broadened spectra, typical of a heating stimulus, as the first discernible response of many of these molecules in aqueous solutions to microwave exposures at frequencies below 10 GHz.

However, there is an important option for biomolecular interactions with static and oscillating magnetic fields through the medium of *free radicals*^{17,18}. Chemical bonds are magnetic bonds, formed between adjacent atoms through paired electrons having opposite spins, and thus, magnetically attracted. Breaking of chemical bonds is an essential step in virtually all chemical reactions, each atomic partner reclaiming its electron, and moving away as a free radical to seek another partner with an opposite electron spin. The brief lifetime of a free radical is about a nanosecond or less, before once again forming a *singlet pair* with a partner having an opposite spin or for electrons with similar spins, having options to unite in three ways, forming *triplet pairs* (reviewed in Reference 2).

During this brief lifetime, imposed magnetic fields may delay the return to the singlet pair condition, thus influencing the *rate* and the *amount of product* of an ongoing chemical reaction.¹⁹ McLauchlan points out that this model predicts a potentially enormous effect on chemical reactions for static fields in the low mT range. For oscillating fields, the evidence is less clear on their possible role as direct mediators in detection of ELF frequency-dependent bioeffects. *Spin-mixing* of orbital electrons and nuclear spins in adjacent nuclei is a possible mechanism for biosensitivities at extremely low magnetic field levels, but these interactions are multiple, complex, and incompletely understood.²⁰ The highest level of free radical sensitivity may reside in hyperfine-dependent singlet–triplet state mixing in radical pairs with a small number of hyperfine states that describe their coupling to nearby nuclei.^{21,22} Although sensitivities to magnetic fields in such a system might theoretically extend down to zero magnetic field levels, singlet–triplet interconversion would need to be sufficiently fast to occur before diffusion reduced the probability of radical re-encounter to negligible levels.

Lander²³ has emphasized that we are at an early stage of understanding free radical signal transduction. “Future work may place free radical signaling beside classical intra- and intercellular messengers and uncover a woven fabric of communication that has evolved to yield exquisite specificity.” A broadening perspective on actions of free radicals in all living systems emphasizes a dual role: first, as messengers and mediators in many key processes that regulate cell functions throughout life and second, in the pathophysiology of *oxidative stress diseases*.

At cell membranes, free radicals may play an essential role in regulation of receptor specificity, but not necessarily through a lock-and-key mechanism. As an example, Lander cites the location of cysteine molecules on the surface of P21-*ras* proteins at cell membranes. They may act as selective targets for nitrogen and oxygen free radicals, thereby inducing covalent modifications, and thus, setting the *redox potential* of this target protein molecule as the critical determinant for its highly specific interactions with antibodies,

hormones, etc. Magnetochemistry studies have suggested a form of cooperative behavior in populations of free radicals that remain *spin-correlated* after initial separation of a singlet pair.²⁴ Magnetic fields at 1 and 60 Hz destabilize rhythmic oscillations in brain hippocampal slices at 56 μT (0.35 to 3.5 nV mm⁻¹) via, as yet unidentified, nitric oxide mechanisms involving free radicals.^{23,25} In a general biological context, these are some of the unanswered questions that limit free radical models as general descriptors of threshold events.

SENSITIVITIES TO NONTHERMAL STIMULI: TISSUE STRUCTURAL AND FUNCTIONAL IMPLICATIONS

CONDUCTANCE PATHWAYS IN MULTICELLULAR TISSUES

In its earliest forms, life on earth may have existed in the absence of cells, simply as a “soup” of unconstrained biomolecules at the surface of primitive oceans. It is a reasonable assumption that the first living organisms existed as single cells floating or swimming in these primordial seas. Concepts of a cell emphasize the role of a bounding membrane, surrounding an organized interior that participates in the chemistry of processes essential for all terrestrial life. This enclosing membrane is the organism’s window on the world around it.

For unicellular organisms that swim through large fluid volumes, the cell membrane is both a sensor and an effector. As a sensor, it detects altered chemistry in the surrounding fluid and provides a pathway for inward signals generated on its surface by a wide variety of stimulating ions and molecules, including hormones, antibodies, and neurotransmitters. These most elemental inward signals are susceptible to manipulation by a wide variety of natural or imposed electromagnetic fields that may also pervade the pericellular field. As effectors, cell membranes may also transmit a variety of electrical and chemical signals across intervening intercellular fluid to neighboring cells, thus creating a domain or ensemble of cells, often able to “whisper together” in a faint and private language. Experimental evidence suggests that these outward effector signals may also be sensitive to intrinsic and imposed electromagnetic fields.

Rather than being separated in a virtually limitless ocean, cellular aggregates that form tissues of higher animals are separated by narrow fluid channels that take on special importance in signaling from cell to cell. Biomolecules travel in these tiny “gutters,” typically not more than 150 Å wide, to reach binding sites on cell membrane receptors. These gutters form the *intercellular space* (ICS). It is a preferred pathway for induced currents of intrinsic and environmental electromagnetic fields. Although it occupies only ~10% of the tissue cross section, it carries at least 90% of any imposed or intrinsic current, directing it along cell membrane surfaces. Whereas the ICS may have a typical impedance of ~4–50 ohm cm⁻¹, transmembrane impedances are ~10⁴–10⁶ ohm cm⁻².

STRUCTURAL AND FUNCTIONAL ORGANIZATION OF THE EXTRACELLULAR SPACE

The organization of cell membrane surfaces and intercellular gutters in detection of these tissue components of extrinsic and intrinsic electromagnetic fields enters the realm of *non-equilibrium* thermodynamics,^{26,27} characterized by *cooperative processes*, mediated by *coherent states* of electric charges on cell membrane surface molecular systems.

Spaces in the ICS are not simple saline filled channels. Numerous stranded protein molecules protrude into these spaces from the cell interior and form a *glycocalyx* with specialized receptor sites that sense chemical and electrical stimuli in surrounding fluid. Their amino sugar tips are highly negatively charged (*polyanionic*) and attract a *poly-cationic* atmosphere, principally of calcium and hydrogen ions. This Debye layer has an extremely high virtual dielectric constant at low frequencies ($D_k > 10^6$ at frequencies <1 kHz).²⁸ Biological cooperative processes occur in systems where at least one energetic parameter in that system (e.g., temperature, electric charge) has been moved far from equilibrium by the addition of external energy. This added energy may induce a population of substrate elements, all at the same higher energy level—a *coherent* energetic state. In such a system, a weak external trigger may elicit a *cooperative* process, with an energy release far greater than in the initial trigger. Capping and patching on the lymphocyte cell surface²⁹ offers a striking example of such a cooperative response, based on intracellular metabolic energy.

The proteins of the glycocalyx offer an anatomical substrate for the first detection of weak electrochemical oscillations in pericellular fluid, including field potentials arising in activity of adjoining cells, or as tissue components of environmental fields. Research in molecular biology has increasingly emphasized essentially direct communication between cells due to their mutual proximity. Bands of *connexin* proteins form *gap junctions* directly uniting adjoining cell membranes. Experimental evidence supports their role in intercellular signaling.

TISSUE DETECTION OF LOW FREQUENCY FIELDS AND RF/MICROWAVE FIELDS AMPLITUDE-MODULATED AT LOW FREQUENCIES: STRUCTURAL AND FUNCTIONAL OPTIONS

Differential bioeffects, to be discussed below, have been reported between certain nonthermal RF or microwave fields with low-frequency amplitude or pulse modulation when compared to exposures to unmodulated continuous wave (CW) fields at similar power levels. The findings suggest, but do not yet establish unequivocally, that this frequency dependence may be a system property in a sequence of molecular hierarchies beyond the first transductive step. If the concept of modulation frequency-dependence continues to gain support in further research, answers must be sought as to the manner of its detection.

For ELF fields, models based on joint static-oscillating magnetic fields have been hypothesized. They include ion

cyclotron resonance,³⁰ where mono- and divalent cations, such as potassium and calcium (abundant in the cellular environment), may exhibit cyclotron resonance at ELF frequencies in the presence of ambient static fields of less than 100 μ T, such as the geomagnetic field. Other models describing ELF frequency dependence have considered phase transitions³¹ and ion parametric resonance,³² but interpretation of this frequency dependence based on ion parametric resonance remains unclear.³³

For amplitude- or pulse-modulated RF and/or microwave fields, there is the implication that some form of *envelope demodulation* occurs in tissue recognition of ELF modulation components, but the tissue may remain essentially transparent to the same signal presented as an unmodulated carrier wave.^{2,34} However, crucial questions remain unanswered. It is not known whether biological low frequency dependence is established at the transductive step in the first tissue detection of the field, or whether it resides at some higher level in a hierarchical sequence of signal coupling to the biological detection system.³⁵ For ELF magnetic fields, experimental evidence points to a slow time scale in inhibition of tamoxifen's antiproliferative action in human breast cancer cells.³⁶

It is a principle of radio physics that extraction of ELF modulation information from an amplitude-modulated signal requires a *nonlinear element* in the detection system. This required nonlinearity may involve a spatial component, such as differential conduction in certain directions along the signal path, or the path itself may exhibit nonlinearities with respect to such factors as spatial distribution of electric charges at fixed molecular sites (so-called fixed charges), or conduction itself may involve a nonlinear quantum process, as in electron tunneling across the transverse dimensions of the cell membrane.

These constraints impose a further essential condition for demodulation to occur in the multicellular tissues of living organisms. There must be a *site for demodulation* to occur. Evidence supports a role for cell membranes to act in this way, based not only on their intrinsic structure, but also on their proximity to neighboring cells in the typical organization of tissues of the body. Typical tissue organization meets the three criteria outlined above but, as a cautionary note, does not allow calculation of possible detection efficiency. Direct neighbor–neighbor cellular interactions will invite our further consideration of properties of cellular ensembles or domains in determining tissue threshold sensitivities.

Directional Differences in Tissue Signal Paths

As already noted, the narrow gutters of the intercellular spaces offer preferred conduction pathways, with conductivity 10^2 – 10^4 higher through extracellular spaces than through cell membranes.³⁷ Thus, the intercellular spaces become preferred pathways for *conduction along (parallel to) cell membrane surfaces* and will reflect the changing directions and cross sections of a myriad channels. Although predominantly an ionic (resistive) conduction pathway, it may also exhibit reactive components, due to the presence of protein molecules in solution.

Nonlinearities in Extracellular Spaces Related to Electric Charge Distribution

A suggested basis for envelope demodulation at cell surfaces may reside in the intensely anionic charge distribution on strands of glycoprotein that protrude from the cell interior, forming the glycocalyx.^{2,38} As already noted, they provide the structural basis for specific receptor sites, and they attract a surrounding cationic atmosphere composed largely of calcium and hydrogen ions. This charge separation creates a Debye layer. In models and experimental data from resin particles, Einolf and Carstensen²⁸ concluded that this physical separation creates a large virtual surface capacitance, with dielectric constants as high as 10^6 at frequencies below 1 kHz. Displacement currents induced in this region by ELF modulation of an RF field may then result in demodulation.

Electron Tunneling in Transmembrane Conduction: Nonlinearities in Space and Time

Experimental studies of transmembrane charge tunneling by DeVault and Chance³⁹ and their more recent theoretical development by Moser et al.⁴⁰ offer an example of extreme functional nonlinearity within the cell membrane. Chance described temperature-independent millisecond electron transfer over a temperature range from 120 K to 4 K. Considering a cell membrane transverse dimension of 40 Å, Moser et al. noted that a variation of 20 Å in the distance between donors and acceptors in a protein changes the electron transfer rate by 10^{12} -fold. Concurrently in the time domain, the electron transfer rate is pushed from seconds to days, or a 10-fold change in rate for a 1.7 Å change in distance.

Issues of Comparability between Bioeffects of ELF Fields, ELF-Modulated RF Fields, and Unmodulated (CW) RF Fields

From the beginning of these studies in the 1970s, it was noted that there were similarities in responses of tissues and cultured cells to environmental fields that were either in the ELF spectrum or were RF and/or microwave fields modulated at ELF frequencies. Available evidence has indicated similarities between certain cell ionic and biochemical responses to ELF fields and to RF and/or microwave fields amplitude modulated at these same ELF frequencies, suggesting that tissue demodulation of RF and/or microwave fields may be a critical determinant in ensuing biological responses.

These findings have been reviewed in detail elsewhere.^{2,18} They are briefly summarized here in experiments at progressively more complex levels in the hierarchies of cellular organization. Early studies described calcium efflux from brain tissue in response to ELF exposures,^{38,41} and to ELF-modulated RF fields.^{38,41–43} Calcium efflux from isolated brain subcellular particles (synaptosomes) with dimensions under 1.0 μ m also exhibit an ELF modulation frequency dependence in calcium efflux, responding to 16-Hz sinusoidal modulation, but not to 50 Hz modulation, nor to an unmodulated RF carrier.⁴⁴ In the same and different cell

culture lines, the growth regulating and stress responsive enzyme ornithine decarboxylase (ODC) responds to ELF fields^{11,45} and to ELF-modulated RF fields.^{9,11,12}

In more recent studies also related to cellular stress responses, Goodman and Blank and their colleagues have reported rapid, transitory induction of heat shock proteins by micro-tesla-level 60-Hz magnetic fields.⁴⁶ In human HL60 promyelocytic cells, these exposures at normal growth temperatures activated heat shock factor 1 and heat shock element binding, a sequence of events that mediates stress-induced transcription of the stress gene HSP70 and increased synthesis of the stress response protein hsp70kd. Thus, the events mediating the field-stimulated response appeared similar to those reported for other physiological stressors (hyperthermia, heavy metals, oxidative stress), suggesting to the authors a general mechanism of electromagnetic field interaction with cells. Their further studies have identified endogenous levels of *c-myc* protein as a contributor to the induction of HSP70 in response to magnetic field stimulation,⁴⁷ with the hypothesis that magnetic fields may interact directly with moving electrons in DNA.^{48–50}

Immune responses of lymphocytes targeted against human lymphoma tumor cells (allogeneic cytotoxicity) are sensitive to both ELF exposures⁵¹ and to ELF-modulated fields, but not to unmodulated fields.⁵²

Communication between brain cells is mediated by a spectrum of chemical substances that both excite and inhibit transaction and transmission of information between them. Cerebral amino acid neurotransmitter mechanisms (glutamate, gamma-aminobutyric acid [GABA], and taurine) are influenced by ELF fields,^{25,53} and also by ELF-modulated microwave fields, but not by unmodulated fields. Kolomytkin et al.⁶ examined specific receptor binding of three neurotransmitters to rat brain synaptosomes exposed to either 880- or 915-MHz fields at maximum densities of 1.5 mW cm⁻². Binding to inhibitory GABA receptors decreased 30% at 16 pulses/s, but it was not significantly altered at higher or lower pulse frequencies. Conversely, 16 pulses/s modulation significantly increased excitatory glutamate receptor binding. Binding to excitatory acetyl choline receptors increased 25% at 16 pulses/s, with similar trends at higher and lower frequencies. Sensitivities of GABA and glutamate receptors persisted at field densities as low as 50 μ W cm⁻².

A selective absence of responses to unmodulated (CW) RF and/or microwave fields reported in many of these earlier studies has focused attention on establishment of threshold sensitivities to CW field exposures. De Pomerai et al.⁵⁴ have reported cellular stress responses in a nematode worm as a biosensor of prolonged CW microwave exposures at athermal levels. Tattersall et al.⁵⁵ exposed slices of rat hippocampal cerebral tissue to 700-MHz CW fields for 5–15 min at extremely low SARs in the range 0.0016 – 0.0044 W kg⁻¹. No detectable temperature changes ($\pm 0.1^\circ\text{C}$) were noted during 15-min exposures. At low field intensities, a 20% potentiation of electrically evoked population potentials occurred, but higher field intensities evoked either increased or decreased responses. The exposures reduced or abolished chemically

induced spontaneous epileptiform activity. Bawin et al.²⁵ also tested the rat hippocampal slice, using ELF magnetic fields. At 56 μ T (0.35–3.5 nV mm⁻¹), magnetic fields destabilized rhythmic electrical oscillations via as yet unidentified nitric oxide mechanisms involving free radicals.

THE ROLES OF FIELD INTERMITTENCY AND EXPOSURE DURATION IN SEEKING OPTIMAL THERAPEUTIC RESPONSES: POSSIBLE “TIME WINDOWS” IN TRANS-MEMBRANE SIGNALING PATHS

It has been apparent from the earliest clinical applications of pulsed magnetic fields to such problems as delayed fracture healing that continuous exposure is not an optimal technique. For example, initial tests with FDA-approved 76-Hz magnetic field generators and cultured bone samples or osteoblast cell lines revealed a range of hormonal and enzymatic responses that occurred only at the onset or immediately after termination of field exposures. In turn, similar clinical testing of various exposure schedules in bone healing led to adoption of intermittent exposure regimes.⁵⁶ In B-lineage lymphoid cells exposed to 60-Hz magnetic fields, Uckun et al.⁵⁷ reported an initial stimulation of tyrosine protein kinases (PTKs) Lyn and Syk. Activation of these Src proto-oncogene PTKs is a proximal and mandatory step in the later activation of protein kinase C. They play “myriad roles” in signal cascades affecting proliferation and survival of B lymphoid cells.

How does a cell distinguish between transient and sustained signaling? Murphy et al.⁵⁸ have shown that in 3T3 fibroblasts, the immediate early gene *c-Fos* functions as a sensor for duration of activation of *extracellular-signal-regulated kinases* (ERK-1 and ERK-2). When ERK activation is transient (30–45 min), its activity declines before the *c-Fos* protein accumulates, and under these conditions *c-Fos* is unstable. However, when ERK signaling is sustained beyond 60 min, *c-Fos* is phosphorylated by still active ERK and by RSK (90 K-ribosomal S6 kinase), thus exposing a docking site for ERK (the DEF domain). Together, these data identify a time-dependent general mechanism by which cells can interpret differences in ERK activation kinetics, including control of cell cycle progression towards either differentiation or proliferation.

Rudiger et al.⁵⁹ have reported an optimal timing sequence of 5 min ON, 10 min OFF in induction of DNA single and double strand breaks in human diploid fibroblasts and blood lymphocytes. The response to 50-Hz sinusoidal magnetic fields was dose dependent with a threshold at 70 μ T. Also using cultured fibroblasts, Litovitz et al.¹¹ determined the minimal duration that a single low frequency modulation frequency must be sustained (*coherence time*) in order to elicit activity in the enzyme ornithine decarboxylase (ODC). Using a 915-MHz field, switching modulation frequencies from 55 to 65-Hz at coherence times of 1 s or less abolished enhancement of ODC responses, while coherence times of 10 s or longer produced full enhancement.

It is abundantly clear that such a patchwork of observations fails to provide a database that would allow selection of

optimal temporal stimulus patterns in specific clinical situations. Nevertheless, they may be considered the first pointers to crucial stimulus parameters, essential in the foundations of all magnetotherapy. They emphasize the importance of further research in that direction to define both the physical characteristics of an optimal stimulus pattern, and more importantly, the cell and molecular biology in underlying tissue substrates.

THE ROLE OF CELLULAR ENSEMBLES IN SETTING TISSUE THRESHOLDS FOR INTRINSIC AND ENVIRONMENTAL STIMULI

Our pursuit of mechanisms mediating tissue electromagnetic sensitivities at nonthermal levels raises questions about the relevance of observed thresholds in the sensory physiology of other modalities. By extrapolation, do these data suggest the need to explore collective properties of populations of cells in setting thresholds by forms of intercellular communication? Do cooperative processes yield one or more faint and private languages that allow ensembles of cells to whisper together in one or more faint and private languages? Do observed tissue-sensory thresholds differ significantly from thresholds measured in single cells in isolation from their neighbors?

EVIDENCE FOR DOMAIN FUNCTIONS AS A GENERAL BIOLOGICAL PROPERTY IN TISSUES

Research in sensory physiology supports this concept, that is, that some threshold properties may reside in highly cooperative properties of populations of elements rather than in a single detector.⁶⁰ Seminal observations in the human auditory system point to a receptor vibrational displacement of 10^{-11} m, or approximately the diameter of a single hydrogen atom.^{61,62} Human olfactory thresholds for musk occur at 10^{-13} M, with odorant molecules distributed over 240 mm^2 .⁶³ and human detection of single photons of bluegreen light occurs at energies of 2.5 eV.⁶⁴ In another context, pathogenic bacteria, long thought to operate independently, exhibit ensemble properties by communication through a system recognizing colony numbers as an essential step preceding release of toxins. These *quorum sensing* systems may control expression of virulence factors in the lungs of patients with cystic fibrosis.⁶⁵

Domain Properties in Systems of Excitable Cells

Bialek addressed the problem of the auditory receptor in quantum mechanical terms. He evaluated two distinct classes of quantum effects: a *macroquantum effect*, typified by the ability of the sensory system to detect signals near the quantum limits to measurement, and a *microquantum effect*, in which “the dynamics of individual biological macromolecules depart from predictions of a semiclassical theory.” Bialek concluded that quantum-limited sensitivity occurs in several biological systems, including displacements of sensory hair cells of the inner ear. Remarkably, quantum limits to detection are reached in the ear in spite of seemingly insurmountable levels of thermal noise.

To reach this quantum limit, these receptor cells must possess amplifiers with noise performance approaching limits set by the uncertainty principle. It is equally impressive that suppression of intrinsic thermal noise allows the ear to function as though close to 0 K. Again, this suggests system properties inherent in the detection sequence. These “perfect” amplifiers could not be described by any chemical kinetic model nor by any quantum mechanical theory in which the random phase approximation is valid. The molecular dynamics of amplifiers in Bialek’s models would require preservation of quantum mechanical coherence for times comparable to integration times of the detector. It is not known whether comparable mechanisms may determine electromagnetic sensitivities as a more general tissue property at cellular and subcellular levels.

Behavioral electrosensitivity in sharks and rays may be as low as 0.5 nV mm^{-1} for tissue components of electrical fields in the surrounding ocean.⁶⁶ These marine vertebrates sense these fields through specialized jelly-filled tubular receptors (ampullae of Lorenzini) up to 10 cm in length, located near the snout and opening on the skin surface through minute pores. Sensing nerve cells lie in the wall of this ampullary tube. In support of a cooperative model of organization of these neurons, behavioral electrosensitivity in sharks and rays is 100 times below measurable thresholds of individual electroreceptor neurons.⁶⁷

Domain Properties in Systems of Nonexcitable Cells: Culture Dimensions and “Bystander” Effects

Jessup et al.⁶⁸ have pioneered studies on the role of gravitational fields in determining trends towards either apoptosis (programmed cell death) or towards cell proliferation. Concurrently, they tested the physical configuration of cell cultures in their influence on these same trends. Based on a colorectal cancer cell line, they compared cells cultured in adherent monolayers with three-dimensional (3D) cultures.

Biochemical measures of apoptosis and cell proliferation were tested (i) in static cultures, (ii) in cultures subjected to slow rotation, and (iii) in cultures exposed to the microgravity of low-earth-orbital space flight. Over the course of 6 days on earth, static 3D cultures displayed the highest rates of proliferation and lowest apoptosis. Rotation appeared to increase apoptosis and decrease proliferation, whereas static 3D cultures in either unit gravity or microgravity had less apoptosis. Expression of the carcinoembryonic antigen as a marker of cell differentiation was increased in microgravity.

For ionizing radiation, the U.S. National Council on Radiation Protection (NCRP) has recommended that estimates of cancer risk be extrapolated from higher doses by using a linear, no-threshold model. This recommendation is based on the dogma that the DNA of the nucleus is the main target of radiation-induced genotoxicity and, as fewer cells are directly damaged, the deleterious effects of ionizing radiation proportionally decline. Experimental evidence seriously challenges this concept.⁶⁹ They used a precision microbeam of α particles to target an exact fraction (either

100% or $\leq 20\%$) of the cells in a confluent cell population and irradiated their nuclei with exactly one α particle each. The findings were consistent with nonhit cells, contributing significantly to the response, designated *the bystander effect*. Indeed, irradiation of 10% of a confluent mammalian cell population with a single α particle resulted in a mutant yield similar to that observed when all the cells in the population were irradiated. Importantly, this effect was eliminated in cells pretreated with 1 mM octanol, which inhibits intercellular communication mediated by gap-junction proteins. "The data imply that the relevant target for ionizing radiation mutagenesis is larger than an individual cell."

CONCLUSIONS

Epidemiological studies have evaluated ELF and RF fields as possible risk factors for human health, with historical evidence relating rising risks of such factors as progressive rural electrification and, more recently, methods of electric power distribution and utilization in commercial buildings. Appropriate models describing these bioeffects are based in nonequilibrium thermodynamics, with nonlinear electrodynamics as an integral feature. Heating models, based in equilibrium thermodynamics, fail to explain an impressive spectrum of observed electromagnetic bioeffects at nonthermal exposure levels. We face a new frontier of much greater significance.

In little more than a century, our biological vista has moved from organs to tissues, to cells, and, most recently, to the molecules that form the exquisite fabric of living systems. We discern a biological organization based in physical processes at the atomic level, beyond the realm of chemical reactions between biomolecules. Much of this signaling within, and between, cells may be mediated by free radicals of the oxygen and nitrogen species. In their brief lifetimes, free radicals are sensitive to imposed magnetic fields, including microwave fields. Free radicals are involved in normal regulatory mechanisms in many tissues. Disordered free radical regulation is associated with oxidative stress diseases, including Parkinson's and Alzheimer's diseases, coronary heart disease, and cancer.

Although incompletely understood, tissue free radical interactions with magnetic fields may extend to zero field levels. Emergent concepts of tissue thresholds to imposed and intrinsic magnetic fields address ensemble or domain functions of populations of cells, cooperatively whispering together in intercellular communication and organized hierarchically at atomic and molecular levels.

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5 A Fundamental Basis for the Effects of EMFs in Biology and Medicine

The Interface between Matter and Function

Jacques Benveniste*

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Our current key–keyhole concept of random collision communication in the body cannot explain the myriad biochemical and physiologic reactions that can occur instantaneously and automatically. A new paradigm of electromagnetic signaling may explain these and other well-accepted but poorly understood observations.

INTRODUCTION

Why should any fields that are nonmaterial by essence act on biological constructions, which, as everybody knows since the beginning of modern biological research, are exclusively made of matter? I remember attending a presentation at a Federation of American Societies for Experimental Biology (FASEB) meeting in the United States about 10 years ago on the effect of electromagnetic fields (EMF) on living matter. At the end of the talk, the presenter was quite apologetic: “It is clear that EMF act on living matter but we don’t know really why since this effect does not fit into classical molecular biology.” Another interesting comment is from Tian Yow Tsong¹:

A prominent biochemist, in a recent conversation with the author, even labeled study of this type of cell-to-cell communication as “astrology” and maintained that signals could only be carried by “the substance of chemistry,” such as molecules or ions. Although any activity of a cell or an organism must ultimately be accountable or linked to reactions of molecules, these reactions can be and most likely are driven by physical forces. Here we will consider how communications through space by force fields (electrical, magnetic, pressure, etc., i.e., the substance of physics) may also accomplish similar tasks and are universally used by cells and organisms.

What is striking in these quotations is the neglect by classical biology of the existence of physical interactions between cells and molecules. T. Y. Tsong himself seems to consider that there are two ways of communication, one, which is supposed to be strictly molecular, and one that is physical.

THE MOLECULAR SIGNAL: FROM PTOLEMEUS TO NEWTON

An interesting aspect of this near blindness of current biology is the universal use of the words *molecular signal* or *signaling*. These words, along with *molecular genetics*, are certainly the most used nowadays by biologists at large. Readers of these pages may be willing to experience personally the reality of this biological black hole. It would be surprising if in any nearby university there were not one conference a month dealing directly or indirectly with molecular signaling. The experiment that I have myself practiced quite often is the following: attend the conference. At the end, ask the following question: I am not a specialist in molecular signaling, but I heard repeatedly the word *signal, signal, signal...* would you please tell me what is the physical nature of the molecular signal?

The result is rather funny, most lecturers and participants reaching near catalepsy. In fact, they do not understand the question. Most of the time an answer will come such as “the molecule is the signal.” It is clear that biologists confuse the origin of the signal with the signal itself (everybody knows that if a man waves a red flag to stop a train, the signal is the red flag, not the man) and that they are reluctant to envision the role of physical forces in the generation and transmission of the signal. It took me several years to realize with

* Deceased.

astonishment that the cornerstone of biology, that is, the communication between molecules, relies on a Ptolemean concept, which postulates that the exchange of information takes place following a mere physical contact between coalescent molecules. The Newtonian principle of action between two distant bodies without any material connection has not yet penetrated biology.

FROM THE “MEMORY OF WATER” TO
DIGITAL (ELECTROMAGNETIC) BIOLOGY

Starting from the surprising result (surprising, to say the least, for the “normal” biologist that I was at that time) that water could convey and keep for quite a long time the specific molecular message, I reached, through several experimental steps, the conclusion that molecular signal could be mimicked by electromagnetic signals in the sound range. The well-known emissions of frequency spectra by molecules, which is the basis of molecular spectroscopy, appear not only to be a physical characteristics but seems to be generating the specific molecular signal that is instrumental in the exchange of information between molecules, probably via the phenomenon of coresonance.

The history of my involvement with “high dilutions” is summarized in Table 5.1.

SIX BIOLOGICAL SYSTEMS

Meanwhile, we have developed several biological systems that allow us to extend the concept of high dilutions being capable of mimicking the effect of the original molecule. Besides the basophil degranulation (1984–1986), we have completed hundreds, if not thousands, of experiments on isolated perfused guinea-pig heart according to Langendorff (1990–1998), and in the same time period, activation of human neutrophils by electronically transmitted phorbol-myristate acetate. Then, in 1997–1998, we worked on a skin test (guinea pig or rabbit) and on an antigen-antibody precipitation system, which allows us to remotely detect any antigen

or groups of antigens. The latter has been our main supporting procedure for research along with the effect of digitally recorded heparin and heparin like substances on plasma or fibrinogen clotting, developed in 1999. More recently, we have constructed an automatic analyzer which performs the digital technique without any human intervention.

We do not have enough space in this short review to show experimental results on all these systems. We have presented these results at many FASEB meetings along these years and recently succeeded, in spite of open censorship from main scientific journals, to publish one full article.² A complete bibliography can be found at http://www.digibio.com/cgi-bin/node.pl?lg=us&nd=n4_7.

THE FLYING MOLECULES

One of our most spectacular experiments was performed in 1996 between Northwerstern University, Chicago, USA, and our laboratory in Clamart-Paris, France. Molecular solutions of ovalbumin, acetylcholine, and, as control, dextran or water were recorded in Chicago using a purpose-designed transducer and a computer equipped with a sound card. The recordings were sent coded to us either on diskettes or by E-mail. Results on 25 files are summarized as follows. The variation in coronary flow of ovalbumin-sensitized guinea-pig isolated hearts induced by digitally recorded ovalbumin was (in percent ± 1 standard deviation) 24.0 ± 1.4 (number of measures = 30), whereas that induced by digitally recorded water was 4.4 ± 0.3 ($n = 58$); $p = 4.5 \times 10^{-17}$. The effect of naive water was 4.9 ± 0.3 ns ($n = 41$) compared to d water, and that of molecular ovalbumin was $0.1 \mu\text{M}$ 28.9 ± 3.7 ns ($n = 19$) compared to digital ovalbumin. Specificity of the system was absolute: no effect was seen when the ovalbumin signal was applied to hearts from nonsensitized animals. Similarly, atropine but not antihistamine inhibited the acetylcholine digital signal as well as the real molecule.

This experiment, I believe, unequivocally demonstrates that the specific molecular signal can be recorded, transmitted at long distance, and then reapplied to the relevant biological system, where it induces the same effect as the original molecule. It is for this experiment that I was awarded a second Ig-Nobel prize. The problem is that no scientific criticism was voiced by the distinguished jury, composed of self-appointed guardians of the scientific purity. Here it is worth noting that our high-dilution experiments have been replicated by six independent laboratories, one doing it twice. How many replications are required for a work to be considered as replicated?

TWO WORKHORSES

Our present main experimental systems are¹ the inhibition of fibrinogen coagulation by digital anticoagulant (see www.digibio.com/video);² the precipitation of antigen-antibody complexes following exposure to the signal of the specific antigen or antibody. The latter method could allow us to remotely detect the presence of microbes (bacteria, viruses, parasites, fungi).

TABLE 5.1
History of High Dilution (Dubbed the “Memory of Water”)

1984	Fortuitous discovery of basophil degranulation triggered by high dilution of anti-IgE antiserum
1988	Publication in <i>Nature</i> , followed by an “inquiry”
1991	Erasing of high dilution activities by an oscillating magnetic field (series of blind experiments in collaboration with a CNRS team)
1992	Electronic transfer (via an amplifier) of biological information to a tube of water
1995	Digitization: recording then replay of the biological signal using a computer
1998	Activation by agitation of a solution at very low concentration (down to 10^{-14}M)

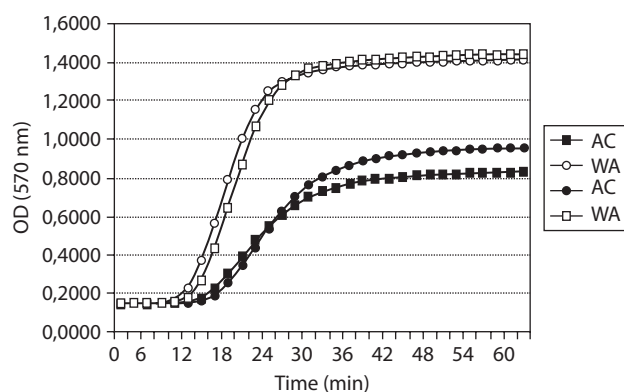


FIGURE 5.1 Thrombin-induced fibrinogen coagulation after exposure to anticoagulant (AC) or water (WA) signals. Blind experiment performed by an automatic analyzer (July 5, 2002).

Figure 5.1 is a representative example of inhibition of coagulation by the signal of an anticoagulant. We have performed hundreds of such experiments.

CONCLUSIONS

This set of results provides an answer for our initial question: EMF act on living matter because the mode of communication between molecules, which is essential to life, is electromagnetic in nature. Molecules communicate like a radio set that receives waveforms carrying specific information from the station to which it is tuned to coresonate and to none other. This communication takes place through water molecules surrounding all biological molecules. Water may have an amplifying role. Some of our data indicate that the signal is indeed emitted by the molecules but is finally conveyed by water, similar to the strings of a violin, which do not create music unless affixed to the resonating wooden box. In addition, we have clear evidence of an influence of some humans on our experiments. This may apply to classical biology too.

These results represent a small theoretical step forward. That molecules emit specific frequencies has been known for decades. We claim, and we believe we have shown, that they use these frequency spectra as their major means of communication. The heretofore physically undefined molecular signal appears to be composed of hertzian waves

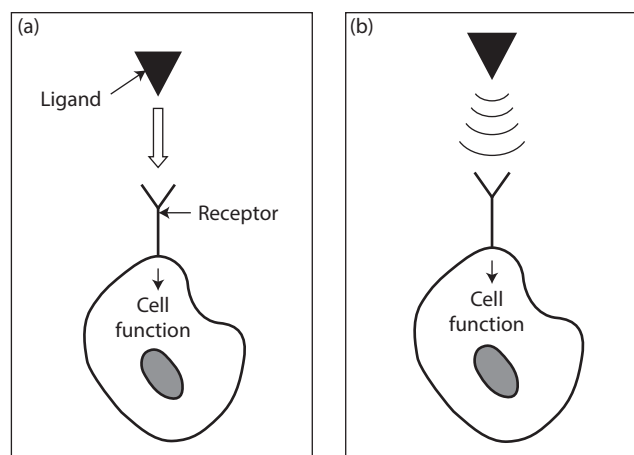


FIGURE 5.2 Molecular signaling. Chemical/molecular versus Physical/atomic communication. (a) 20th century communication structural contact, (b) 21st century communication structural contact.

at least in the sound range. This is not a scientific revolution, as stated by conservative scientists who accused us of “negating the existence of molecules, hence two centuries of research.” We simply replace the arrow that is supposed to represent the interaction of two ligands with a symbol representing the waveforms that support this interaction (Figure 5.2).

As a vast array of technological devices are now at our disposal to record, transmit, analyze, modify, and digitize these types of signals, this advance could profoundly change our views and our experimental approaches to biology and medicine. The now obvious failure of classical structural biology to explain the complex mechanisms supporting life and provide solutions to its disorders shows that it is about time that biology makes, at long last, its Newtonian revolution, that is, going from matter to energy.

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6 Subtle Energies and Their Roles in Bioelectromagnetic Phenomena

William A. Tiller*

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Various studies are presented to illustrate how human consciousness and intentionality can generate subtle energy fields that are translated into electromagnetic fields having significant biochemical and physiologic effects. Such subtle energies can also be stored in an electrical device and utilized to change the pH of a solution, increase the *in vitro* thermodynamic activity of enzymes and increase the *in vivo* ratio of ATP to ADP in developing fruit fly larvae to significantly reduce the maturation time to adult flies.

INTRODUCTION

The existing formalism for the quantum mechanical (QM) paradigm of physics is perhaps the greatest stumbling block that we have in trying to understand the essential differences that exist between bioelectromagnetism (bio-EM) and conventional electromagnetism (EM). Most scientists and engineers tend to think that bio-EM is just conventional electricity and magnetism applied to biological systems—it is not! In this chapter and the next, we show why it is not and how to begin revealing the differences.

To help the reader understand these differences, the next section deals briefly with key concepts and definitions that need to be comprehended in order to grasp the viewpoint

of this chapter. In the section “Some General, Background Psychoenergetic Data,” some general psychoenergetic experimental data will be utilized to illustrate how human bio-EM can be very different from conventional EM. In this section, one particular example will be utilized to show how human consciousness can generate subtle energy fields that, in turn, translate into experimentally measurable EM-fields. In the section “Some Robust Effects of Human Intention on Space Conditioning,” recent experimental studies by the author and his colleagues regarding some very robust effects of human intention on “conditioning” the experimental space to a higher EM gauge symmetry state will be presented. In turn, this higher symmetry level strongly influences physical reality via altered material properties manifesting in experimental measurements. In the next chapter, this work is extended to show why humans, and probably all vertebrates, contain a higher EM gauge symmetry state system functioning in their bodies and this system *strongly* influences their bio-EM. Here, we will see how subtle information-energy fields convert, in part, to measurable *E* and *H* fields, and how conscious intent can act as a true thermodynamic variable to influence the magnitude of *E* and *H*, the only fields we can instrumentally quantify at the moment. There, we finally get to discuss some quantitative differences between bio-EM and standard EM. A multidimensional theoretical model is presented that

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both rationalizes the aforementioned experimental observations and provides a meaningful quantitative basis for expanding our QM paradigm. Finally, the next chapter closes by returning to day-to-day expectations for one area of near-future applications of bio-EM and subtle energies in the area of medical therapeutics.

SOME CONCEPTS AND DEFINITIONS

DE BROGLIE'S PARTICLE-PILOT WAVE CONCEPT

Classical mechanics dealt only with particles, whereas this concept, which became one of the cornerstones of QM, is perhaps best illustrated by Figure 6.1.^{1,2} De Broglie proposed that every particle had a pilot wave envelope enclosing it and moving at the particle's velocity. This concept required that, as this pilot wave envelope moved along, some new wave components moved into the envelope while some old wave components moved out. Calling the particle wave velocity v_p and an individual wave component velocity v_w , relativity theory requires that the following relationship holds:³

$$v_p v_w = c^2 \quad (6.1)$$

where c is the velocity of light. Since $v_p < c$ always, $v_w > c$ always, these waves were dubbed "information" waves in order to not make trouble for relativity theory (see Chapter 18, Figure 40.1).

Although in QM, de Broglie's concept (proven experimentally) became known as wave-particle *duality*, this author proposes that nature expresses itself simultaneously via its particle aspect and its information wave aspect. This means that the quantitative magnitude of *any* physical measurement is comprised of two parts: (i) the coarse particulate part and (ii) the fine information wave part. Here, it is important for us to realize that all the waves of our cognitive experience are merely modulations of particle fluxes or particle densities in space-time. All the continuum type EM waves, drawn in electrical engineering textbooks, are actually de Broglie's information waves traveling through the vacuum level of substance.

THE VACUUM LEVEL OF SUBSTANCE

The fundamental particles making up our atoms and molecules are so tiny that they occupy only a miniscule amount of the total space. The remainder of that space (99.999 + %) is the vacuum level of substance. This particular vacuum, like that between the planets, *is not empty*. For QM and relativity theory to be internally self-consistent, others have calculated that it must contain an energy density, in mass units, of 10^{94} g/cm³. This is a huge number. What it means in more practical terms is that provided we can assume our universe to be flat (and current day astronomers say that we can), there is a trillion times more latent energy stored in the volume of a single hydrogen atom's vacuum level than in all the mass of all the planets and all the stars in our universe out to a radius of 20 billion light-years. Thus, the vacuum level of substance

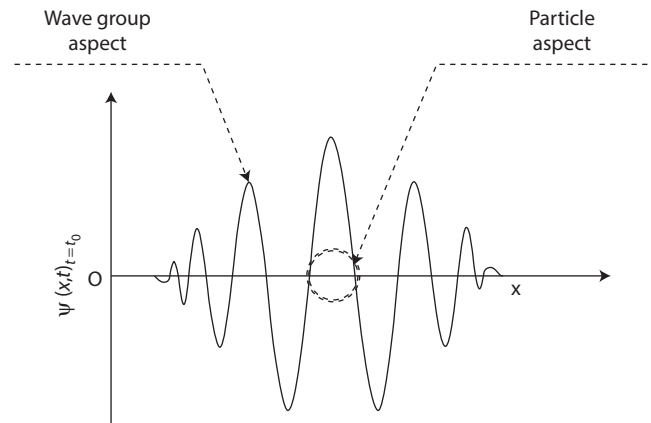


FIGURE 6.1 A group of pilot waves for a physical particle located somewhere in the group.

is what we must look to for our scientific and technological future.

GAUGE SYMMETRY

In current physics, one of the key discussions that connects the *Gauge* condition to important concepts and hypotheses is that associated with the big bang concept. Here, one encounters a description of energy and eventually matter undergoing evolutionary changes of state, from states of higher fundamental symmetry to states of lower fundamental symmetry.⁴ At amazingly short times in this proposed process, gauge transformations occurred from very high symmetry states and progressively drop to the lower state of the SU(2) EM gauge and then on down to the U(1) EM gauge symmetry level—our present cognitive domain.

Symmetry changes for matter still occur at the U(1) gauge level but these all involve collective interactions described as changes of state of the plasma → gas → liquid → solid kind as the temperature continues to fall. Further lowering of temperature leads to magnetic dipole ordering in some materials, electron pairing in others and phonon-photon coherence development in still others. All of this is a manifestation of the lowering of the Gibb's free energy for the system.

We are all familiar with the simple symmetry rule of rotational invariance, examples being 60° for the snowflake, 90° for the cube and 120° for the triangle. For the U(1) EM gauge symmetry state, it is a little more complex with the major requirements being (i) the coexistence of electric monopoles and magnetic dipoles, (ii) Maxwellian equations for EM, (iii) Abelian algebra applies ($XY - YX = 0$, where X and Y are unique fields), and (iv) a completely disordered vacuum level. On the other hand, for the SU(2) EM gauge symmetry state (a higher Gibb's free energy state than the U(1) state), the situation is still more complex in some ways. Here, the major requirements for this chapter are (i) the coexistence of both electric and magnetic monopoles, (ii) non-Maxwellian EM,⁵ (iii) nonabelian algebra ($XY - YX \neq 0$), and (iv) the existence of domains of order in the vacuum.⁶

What one notes regarding the big bang process is that, *unimpeded by consciousness inputs*, thermodynamics will drive the system towards a lower and lower Gibb's free energy state.

THE CONDITIONING OF SPACE

This involves the sustained use of human intention at a particular spatial location. This raises the EM Gauge symmetry condition, metastably at first and then, eventually, to a sufficiently high state that a symmetry phase transition can be nucleated at the vacuum level of that location. This stabilizes the higher symmetry state for an extended period of time (years), but perhaps can be destabilized by the reverse intention.

OUR PARTICULAR BICONFORMAL BASE-SPACE FRAME OF REFERENCE (FR)

The current reference frame for QM is distance-time, (x, y, z, t) , and this is fine provided no mathematical singularities are present.^{1,2} However, QM abounds in singularities and relativity theory has a major one at $v = c$. Based on Equation 6.1, Figure 6.2 illustrates this latter singularity. When mathematical singularities are present in the domain of interest, it is well known that the expansion of any mathematical function about a point in the domain requires the use of Laurent's procedure rather than Taylor's procedure, which is usually used. As an example, for the Gibb's free energy function G , we must use

$$G(z) = \underbrace{G(z_0) + \sum_{n=1}^{\infty} a_n (z - z_0)^n}_{\text{Taylor}} + \underbrace{\sum_{n=1}^{\infty} b_n (z - z_0)^{-n}}_{\text{Laurent}} \quad (6.2a)$$

where z_0 is the point about which we are expanding. In the thermodynamics of homogeneous systems, only the first ordered terms are considered. Typically, one either lets z represent the thermodynamic intensive variables of P, T, n_j , etc.

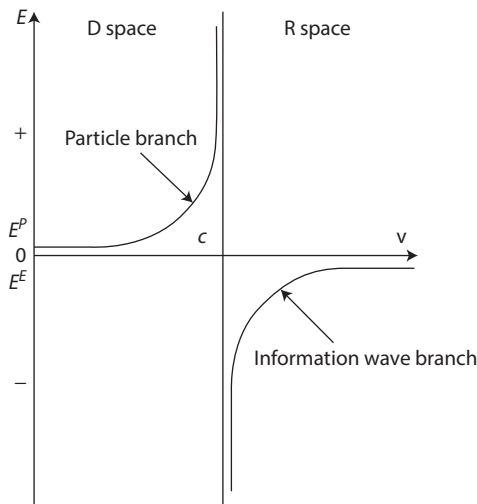


FIGURE 6.2 Energy-velocity diagram for a D-space particle ($v < c$ branch) and its R-space pilot wave conjugate ($v > c$ branch).

(P = pressure, T = temperature, n = number of moles of chemical species j , etc.) or the distance-time coordinates, (x, y, z, t) .^{2,7} For our interest here, it is the first-order expansion terms in distance-time that are important, therefore, Equation 6.2a shows us that we have terms involving (x, y, z, t) plus terms involving $(x^{-1}, y^{-1}, z^{-1}, t^{-1})$. If we define $b'_1 = b_1/2\pi$, $k_j = 2\pi/(z_j - z_{j0})$ and $z_j = (x, y, z, t)$, then we can begin to see our biconformal base-space reference frame developing out of Equation 6.2a. It is two, four-dimensional subspaces, (x, y, z, t) and its reciprocal $(x^{-1}, y^{-1}, z^{-1}, t^{-1})$ or (k_x, k_y, k_z, k_t) . The reciprocal coordinates are all frequencies, x^{-1} = number per unit distance = a spatial frequency and t^{-1} = number per unit time or a temporal frequency. Thus, Equation 6.2a, in its first-order form but with all coordinates represented, becomes

$$\begin{aligned} G - G_0 &\approx a_x(x - x_0) + a_y(y - y_0) + a_z(z - z_0) + a_t(t - t_0) \\ &\quad + b'_x k_x + b'_y k_y + b'_z k_z + b'_t k_t \\ &= \text{D-space } (x, y, z, t) \text{ terms} \\ &\quad + \text{R-space } (k_x, k_y, k_z, k_t) \text{ terms} \end{aligned} \quad (6.2b)$$

Here D space refers to direct space, while R space refers to its reciprocal space. Together, they form a unique 8 space.

One of the beautiful things about this particular biconformal base-space RF is that it naturally separates into particle space (D space) and information wave space (R space). Another is that the D-space contribution allows only local forces while the R-space contribution allows nonlocal forces. This is because things that are far away and far apart in D space (like planets and stars) are very close together in the low-frequency domain of R space. A third important outcome of choosing this particular RF is that, for such reciprocal 4 spaces, mathematics *requires* that any substance quality in D space can be quantitatively related to its conjugate equilibrium quality in R space by a *Fourier transform* type of relationship and vice versa. This latter outcome means that, for *any* physical measurement Q_M , we must have

$$Q_M = Q_D + Q_R. \quad (6.3)$$

And we have a quantitative pathway connecting Q_R to Q_D (the modified Fourier transform). Thus, we must begin to look at physical reality as consisting of two layers: (i) the coarse, particulate layer that we all cognitively access; and (ii) the fine information wave layer, which most of us do not presently cognitively access because it functions at the vacuum level of nature.

DELTRON COUPLING

As we will see later in the Section "Some Robust Effects of Human Intention on Space Conditioning," a strong DC magnetic field polarity effect occurs on the pH of water when the water is in a conditioned space² but not when it is in an unconditioned space (the U(1) EM Gauge symmetry state). The fact that such a polarity effect can arise would seem to suggest that magnetic monopoles are somehow being accessed. This

implies that the information wave aspect of substance may be “written” by the magnetic monopoles. If this is so, then the actual existence of any form of EM requires a meaningful although not direct interaction between electric monopole substance traveling at $v < c$ and magnetic monopole substance traveling at $v > c$ (see Equation 6.1). Let us invent a higher dimensional coupling substance that is *outside* the constraints of relativity theory and can travel at both $v < c$ to interact with D-space substances *and* at $v > c$ to interact with R-space substances. I label this coupling substance “deltrons” from the next higher dimension (9 space), which I have elsewhere¹ designated as the domain of emotion.

SUBTLE ENERGIES

We are all familiar with the four fundamental forces of gravitation, electromagnetism, the long-range nuclear force, the short-range nuclear force, and the energies that they give rise to. Subtle energies are none of these! Subtle energies need not be weak, but they are elusive because we do not presently have direct detection probes for them. At this point in time, it is thought that all subtle energies reside at the *vacuum level* of nature (see Figure 6.3). At present, only the information wave substance and the deltron substance have been articulated and discriminated by this author. However, acupuncture energies, homeopathy energies, remote viewing energies, etc., are all thought to fall into the R-space category.

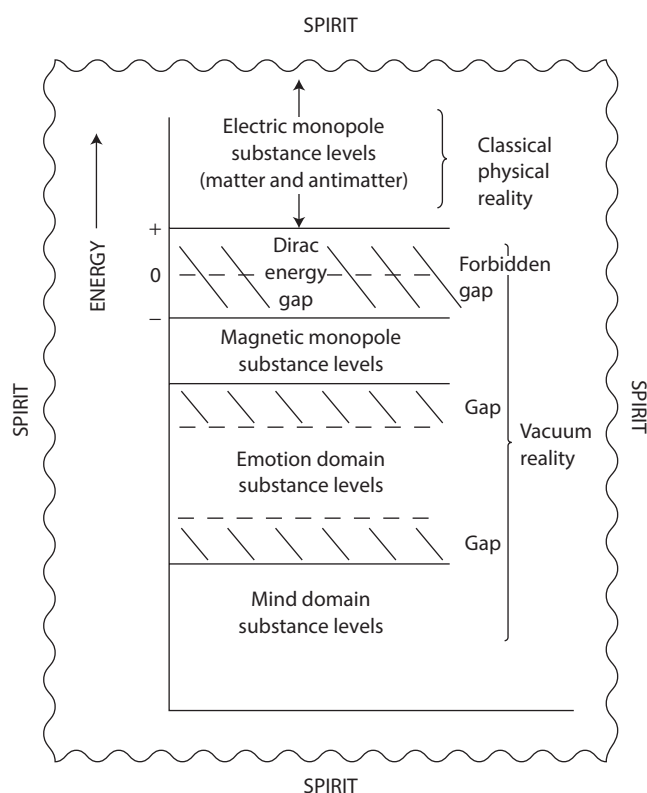


FIGURE 6.3 An energy level diagram embracing both classical physical substance and “unseen” vacuum substances.

EQUILIBRIUM CLUSTER POPULATIONS

Many scientists hold the naive view that all liquids, and particularly pure water, are completely homogeneous down to the atomic or molecular level and exhibit structural characteristics in complete accord with the random network model proposed over a half-century ago for glasses.⁸ However, nothing could be further from the truth and even the nanoscale heterogeneous perspective of water’s structure has grown greatly in the last few decades and is available in some fine reviews.⁹ This topic is considered here because it is so relevant to medical therapeutics.

From a theoretical perspective,¹⁰ one naturally expects pure water to contain a wide spectrum of thermodynamically distinguishable species because the configurational entropy contribution of each unique species lowers the bulk free energy of water. The equilibrium population, N_i^* , of each unique species i , is given by $N_i^* = N_0 \exp(-\Delta G_{Fi}/kT)$, where N_0 is the monomer H_2O concentration available for forming these new species, kT is the thermal energy and ΔG_{Fi} is the free energy of formation of the i species from this multispecies “soup.” These species range from H^+ , OH^- and monomeric H_2O in the H-bonded network to clusters, differentiated by both polymorphic structure and size, and to microvoids of varying size and internal gas content. Although the statistical ensemble of these associated entities exhibits a stable equilibrium population distribution at any particular temperature and pressure, a particular cluster may dissociate and another re-form at a high frequency to stabilize the total ensemble on time average. Whenever N_i falls below or exceeds N_i^* , a thermodynamic driving force exists to change N_i toward N_i^* at the fastest rate allowed by the local reaction kinetics. It is also important to note that a specific solute, j , added to water also has a specific equilibrium population, N_j^* , given by the above formula with ΔG_{Fj} equal to the free energy of solution for j . However, the concentration of this species can only be changed by dilution with pure water or by the addition of more solute. As all of these various N_i^* and N_j^* species are enfolded into the bulk water host via surrounding envelopes of H bonds that join the general H bond network of the water and, as overall free energy minimization of the total system may be constrained by the availability of such H bonds, solute agglomeration might be an anticipated result below some specific degree of dilution.¹¹ If H bond availability can be a thermodynamic and perhaps a kinetic rate-limiting constraint in water, this suggests that a large fraction of the H_2O molecules present in bulk water are associated with unique complexes of the types delineated above. From the foregoing, one must expect great heterogeneity in the fluid aspect of human cells.

EXTERNAL FIELD EFFECTS

General electric E and magnetic H field effects on the thermodynamic properties of a homogeneous liquid can be inferred from References 2 and 10. However, the nanoscale heterogeneity of water discussed above introduces several new and important factors that need to be addressed here. This arises

from the fact that our standard environment contains a DC magnetic field, AC electromagnetic fields of a wide range of frequencies plus atmospheric ion-generated DC electric fields. For either DC or AC fields, the clusters and microbubbles have different electric and magnetic susceptibilities relative to bulk water. Thus, both electric and magnetic dipoles are induced at these interfaces¹² and, for nonuniform fields, will migrate towards the high field regions under the influence of dielectrophoresis and diamagnetophoresis¹³ forces. These quasiparticles will migrate towards the high-field regions of the bulk water sample where many will annihilate ($N_i > N_i^*$) while new cluster/nanobubble creation events must occur in the low field regions ($N_i < N_i^*$) adding to the overall dynamism of change. It has been shown recently that magnetically shielded water stays for a remarkably long time in metastable states without actively moving towards equilibrium and that miniscule H fields greatly enhance the rate of pH and ORP progression towards some stationary state with the rate of progression increasing strongly with the magnitude of H .¹⁴ Abundant experimental data exists to confirm many strange effects associated with electromagnetic field effects and water.¹⁵ Surprisingly, when the water is first degassed before EMF exposure, these strange effects are absent.¹⁶ Direct electron microscope evidence also exists for magnetic field alteration of the Helmholtz layer thickness at solid–water interfaces.¹⁷

Perhaps a simple example from medical therapeutics will best illustrate the complexity of the issues here. Suppose we have a device placed around a human's knee that creates a macroscopically uniform AC electromagnetic field intensity (E^2 and H^2) outside the knee. One might quickly assume that nothing will happen inside the knee because this imposed field is macroscopically uniform. However, inside the knee, the structure is polyphase (bone, cartilage, tendons, fluid, "colloids," ions, etc.) and thus heterogeneous with respect to electric and magnetic susceptibilities. This means that, *inside* the knee, the E and H fields are macroscopically non-uniform and it is these internal environment fields that drive "colloids" and small dipoles to drift towards the local high field regions. Further, with the passage of time, these "colloids" and small dipoles concentrate in certain regions and now create *DC fields* that, in turn, initiate local ion movements (electrophoresis) to neutralize such induced DC fields.

The main point to be communicated by this final section is that the presence of any structural heterogeneities in water leads to local heterogeneities in electric permittivity and magnetic permeability and these, in turn, respond directly or indirectly to ambient E and H fields so as to cause drift movement of such moieties in the solution. Such long-range movement upsets the homeostasis of the solution with a variety of interesting consequences.

SOME GENERAL, BACKGROUND PSYCHOENERGETIC DATA

In a recent book, Radin¹⁸ has provided clear and incontrovertible evidence to support the existence of extra sensory

perception (ESP) capabilities in humans. Although the effect size is small for the average population, it is clearly nonzero. This field also has its superstars, like a Michael Jordan or a Tiger Woods, where the effect size can be very large. Ingo Swann¹⁹ and Edgar Cayce²⁰ are two names that come readily to mind. For today's medicine, this type of data sheds strong light on the so-called placebo effect. The prevailing medical view is that nothing real has occurred and that any improvement is delusional. In Benson's work²¹ among patients receiving a variety of treatments they believed in, but for which medicine finds no physiological basis, treatments were effective 70%–90% of the time. However, when the physicians doubted whether these treatments actually worked, their effectiveness dropped to 30%–40%.

Similar belief-related success was observed in Stewart Wolf's work²² with women who experienced persistent nausea and vomiting during pregnancy. First, sensors were positioned in their stomachs so that contractions could be recorded. Next, they were given a drug that they were told would cure their nausea. In fact, they were given Ipecac. However, because of their belief, the women reversed the laboratory-proven action of the drug and their measured stomach contractions damped down to negligible values. Further, Enserink²³ has pointed out that "when companies started testing drugs for obsessive-compulsive disorder back in the mid-1980s, the placebo response rate was almost zero. As time went on, this response rate began to creep upward, up to a point when one could reasonably conclude that some clinical trials failed because of high placebo response rates." A recent meta-analysis of 19 antidepressant drug trials revealed that the placebo effect on average accounted for 75% of the effect of *real* drugs. Although many feel that this data represents a kind of soft underbelly that both academic and industry researchers are more comfortable leaving out of sight, others are fascinated by the power of the placebo effect viewing it not as a problem but as a source of insight into mental health. Going even further, what is it saying about the *actual* laws of nature, as distinct from our metaphysical assumptions about them, and *why* has the magnitude of the placebo effect increased so remarkably in the last 20 years?

Another major psychoenergy experiment involves the conscious cognition of objects, terrain, atmospheric conditions, and so forth located hundreds to thousands of miles away, given only the coordinates of the location. This experiment, originally conceived, conducted and developed by Ingo Swann and given the name *remote viewing*, was refined and perfected by him in association with Puthoff and Targ²⁴ at Stanford Research International. For government service remote viewers, successful completion of a training program required a minimum of 85% accuracy with respect to the coordinates of 20 blind targets. In some cases time coordinates, past or future, were also involved.

A more familiar mode of remote viewing involves one's ability to "tune in" to a specific individual and view a specific remote locality through that individual's eyes. This mode of remote viewing ability is more easily acquired and has been replicated in many laboratories around the world.²⁴

Dossey,²⁵ Targ and Katra²⁶ plus many others have clearly shown that humans are not only capable of highly accurate long-range cognition of local details plus events but they are also capable of eliciting human health transitions at such distant locations. From Dossey's three eras of medicine model, Era III-Medicine is defined by *nonlocal* approaches to healing.²⁵ It views the mind as unbounded and unconfined to points in space and time so that this category of healing events may bridge persons who are widely separated from each other. This category of medicine goes well beyond today's view of physics so that mind, not matter, is ultimately considered as being primary. Expanding on nonlocal force and influence effects, a great deal of data²⁷ is now available to show that both *Qigong* masters and adepts can significantly influence materials and processes both locally and nonlocally located. For example, Yan Xin emitted his *Qi* into samples of tap water both from a local arrangement and via a nonlocal arrangement (~7 km away) and any change in the water's Raman spectrum was investigated.²⁸ There are two peaks in the Raman spectrum of normal water: one very large peak is at 3430 cm⁻¹, corresponding to the stretching vibrational mode of OH, and one weak at 1635 cm⁻¹, corresponding to the bending vibration mode for HOH. Before Yan Xin's *Qi* emission, this is what was observed for all samples. However, after *Qi* emission, there was a huge peak (~18 times higher than the normal peak at 3430 cm⁻¹) ranging from 1000 cm⁻¹ to 3000 cm⁻¹ observed in the Raman spectrum for the water samples. This huge peak decayed by ~2/3 within the first 1.5 h and it had completely disappeared after ~2 h from *Qi* emission, leaving a Raman spectrum that was essentially identical to that of the untreated water.

All of the aforementioned works are examples of subtle energies producing substantial effects on physical reality! Now, let me provide a few examples from this author's own work.^{1,29}

In the 1970s, I carried out a series of experiments with a man whose bio-EM field was such that he had a unique ability with cameras and its photographic film. Whenever he took a picture while he was experiencing a particular familiar feeling in his seventh cervical and fourth thoracic vertebrae, some striking anomaly would appear in the photograph. His held intention during the picture-taking process was, he said, "to reveal God's universe."

My experiments with him used two cameras, one of them sensitized by keeping it close to his body for several days and the other unsensitized. Both cameras were mounted on the same tripod and tripped with a single shutter release. Ordinary colored film was used in both cameras and was processed by its manufacturer, and the subject was never allowed to touch the film. Often, though not always, pictures taken with the sensitized camera showed one or more people as if they were partially transparent, or translucent, so that objects located behind them could be seen "through" them.^{29,30} The pictures from the unsensitized camera appeared normal. On other occasions, clear pictures were taken via the sensitized camera with the lens cap firmly in place on the camera.³⁰

My interpretation of this phenomenon is that

1. Some radiations exist in nature that can travel through materials that are opaque to visible light.
2. Because of some presently unknown quality inherent in the subject's biofield, these radiations can be detected by film in the sensitized camera.
3. Some time is required for the camera placed in this special human energy field to acquire its anomalous capacity.
4. The anomalous capacity leaks away in about an hour or so unless continuously pumped by the energy field of the subject.

In a second set of studies,^{29,30} an AC voltage at 450 Hz was applied to dielectric-coated electrodes that bounded a 2 mm layer of gas in a sandwichlike gas discharge device (see Figure 6.4). The applied voltage peak to the device was kept 10%–15% below the breakdown voltage for the layer of gas, and electron "microavalanches" passing through the gas were monitored by a pulse counter that could be set to count any pulse over a predetermined size.

Typically, the pulse counter was set to just miss the largest avalanches traveling across the gas. Thus, the system was poised but yielding a zero count for many hours until a human subject attempted to influence it. Almost a thousand or so experimental runs involved a person holding their hands about 6 in. from the device and *intending* to increase the count rate. Over a 5-min/period of such intending, the number of recorded pulses often went from zero to the 50,000 range.

If the subject's hands were not held near the device but the intention was still to increase the count rate, total counts could still be increased from zero to a range of 10,000–20,000 counts within 5 min. If, during the same type of experiment, the subject's intention was directed *away* from the device by being focused on a different mental task, no change in the count rate occurred, and the total counts was still zero at the end of 5 min even though the subject's hands were straddling the device.

From these results, I deduced that

1. People manifest a heretofore undetected energy that has the property of increasing both electron microavalanche size and number in a nearby gas discharge system.
2. A person can direct the flow of this energy in a chosen direction by their mind.
3. The mind–electron interaction can be effective over appreciable distances.

Elmer Green and his associates at the Menninger Clinic devised a simulated healing experiment involving an accomplished healer in a specially designed environment in a larger room^{29,30} (see Figure 6.5). The healer, wired to a variety of electrophysiological measurement instruments, stood or sat on an electrically insulated framework placed within four

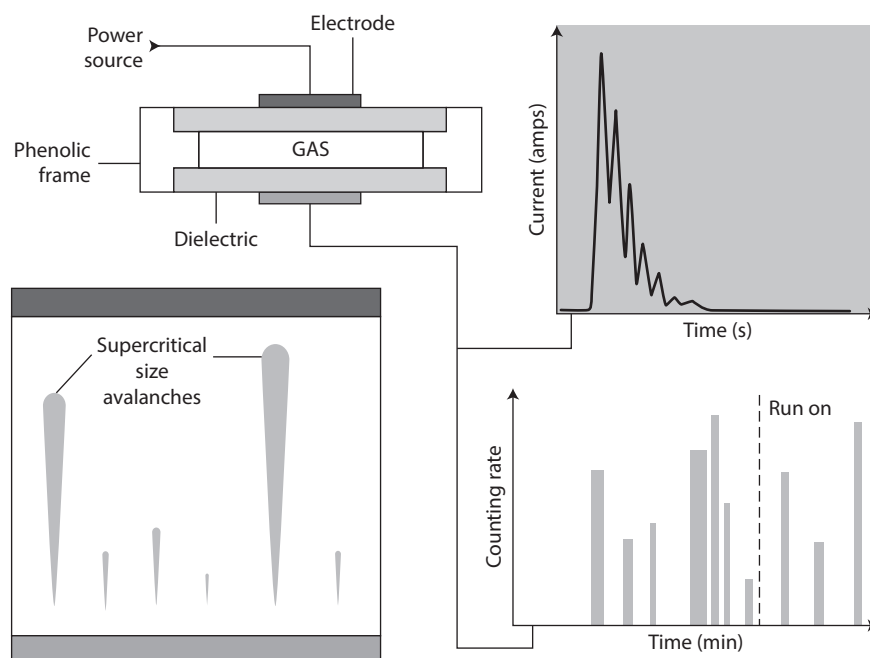


FIGURE 6.4 The gas-discharge experimental setup comprised a high fidelity, high-voltage power source, the gas discharge device, and a monitoring system. This schematic illustration shows electron avalanches passing through the gas, a typical oscilloscope tracing of total electron avalanche current versus time and a plot of the count rate as a function of time during an experimental run.

large, square copper walls (one in front, one behind, one above, and one below). Electrically insulated electrometers simultaneously recorded the voltages of these four walls plus that from an electrode placed on the healer's earlobe.

Instead of the 10- or 15-mV baseline reading with 1-mV ripples that are typical of the human body, it was observed that the healer's body voltage often plunged by 30–300 V and then returned to baseline within 0.5–10 s. This astoundingly large voltage pulse is about 100,000 times normal. Correlated pulses of 1–5 V appeared on each of the four copper walls. In a 30-min simulated healing session, the healer manifested 15 of these anomalously large pulses.

From this experiment, I generated a theoretical model³⁰ of a nondirectly observable subtle energy pulse emitted from some locations in the healer's body that was transduced through a series of stages and manifested as an electric dipole pulse at a specific location in the healer's body (see Figure 6.6). With this model and the experimental data, I was able to make a quantitative analysis from the 15 pulses.³⁰

In 13 of the 15 pulses, the place of origin in the healer was the lower abdomen. The dipole was predicted to extend from the ear (negative charge end) to the feet (positive charge end), and it required quite small current flows for a very short time to achieve the result (~5 nA flowing for ~1 s). Such a current flow is much less than that typically observed when two different acupuncture points on the body are connected.

For the other two anomalous pulses, it was necessary to propose the formation of two simultaneous electric dipole pulses to account for the different type of data observed. From this data, the location of the second dipole was predicted to be in the head.³⁰

What I deduced from this study was that (i) the healer's intention to heal can manifest, ultimately, as large, observable electric voltage pulses in physical reality, (ii) some medium exists that couples the nondirectly observable subtle energy to an observable physical energy, and (iii) a precise mathematical analysis can be generated to concretize this elusive concept.

From what is to come later, a hypothesized subtle energy field, χ , is pulsed in time. This is transduced to a magnetic vector potential, A , profile in time of a gaussianlike shape. From our conventional U(1) EM gauge symmetry equations, this leads to the type of E-field pulse illustrated in Figure 6.6c which, in turn, causes ion movement in the electrolyte of the body to create a charge dipole of the type needed to rationalize the experimental data.

SOME ROBUST EFFECTS OF HUMAN INTENTION ON SPACE CONDITIONING

For the past several years, my colleagues and I have been conducting specific target experiments on the use of intention imprinted electrical devices (IIEDs) to influence both inanimate and animate materials with respect to some of their properties.² For each target experiment, one starts with two identical simple electronic devices housed in 17.8 cm × 7.6 cm × 2.5 cm black plastic boxes. One isolates them from each other by first wrapping them in aluminum foil and then storing them in separate electrically grounded Faraday cages (FCs). One is left as is and is designated as the "control." The other is taken out of its FC, unwrapped, and "charged" with the specific intention or the particular target

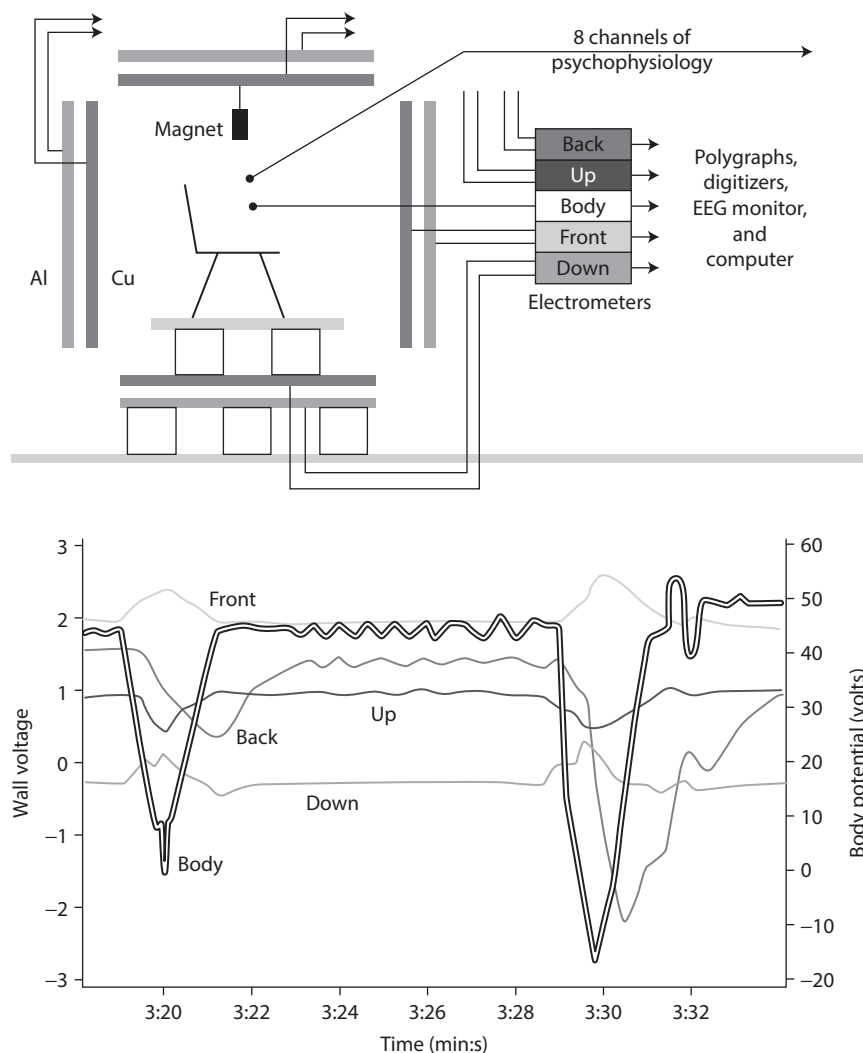


FIGURE 6.5 In the copper-walled meditation room, four pairs of insulated copper and aluminum panels float in electrical space around a research chair, which also floats electrically, insulated from the “down” panel by glass construction blocks. Signals from the subject’s body and from the four copper walls are fed into electrometers, and data from all channels are forwarded to polygraphs, digitizers, and a computer. The graph shows an example of simultaneous body and wall potentials.

experiment under consideration. It is then rewrapped in Al foil and returned to its FC.

This charging process involved the services of four highly qualified meditators to “imprint” the device with the specific intention following a specific protocol (see the appendix of section IA in Reference 2). Then, on separate days, the control device and the imprinted device were shipped via Federal Express about 3000 km to a laboratory where the actual target experiments were conducted by others.

When not in use, the devices were always wrapped in Al foil and stored in individual FCs. This was found to be necessary because without it, even if the devices were separated by 100 m and in the off-state, the control device gradually became imprinted with that specific intention and we eventually lost our “control.” Following this isolation procedure, we could maintain the imprint charge in the active device for ~4 months before reimprinting was felt to be needed.

TARGET EXPERIMENT 1

Here, the specific intention was to either increase or decrease the pH of aqueous solutions and purified water (ASTM type 1) by one full pH unit. Separate IIEDs were needed for $\Delta\text{pH} = +1$ and $\Delta\text{pH} = -1$. Thus, considering both, a swing of hydrogen ion concentration by a factor of 10^2 was attempted without any intentional chemical additions except those entering via contact with the local air atmosphere. The experimental setup used is shown in Figure 6.7 where a modern, high-quality pH meter (accuracy of ± 0.01 pH-unit, resolution of 0.001 pH-unit) and a high-quality temperature probe (accuracy of $\pm 0.012^\circ\text{C}$, resolution of 0.001 $^\circ\text{C}$) were utilized. The device was merely placed ~15.25 cm (6 in.) from the water and turned on (total radiated electromagnetic energy $< 10^{-6}$ W).

Figure 6.8 demonstrates an obvious difference in the coherence state for one of the aqueous solutions, exposed for

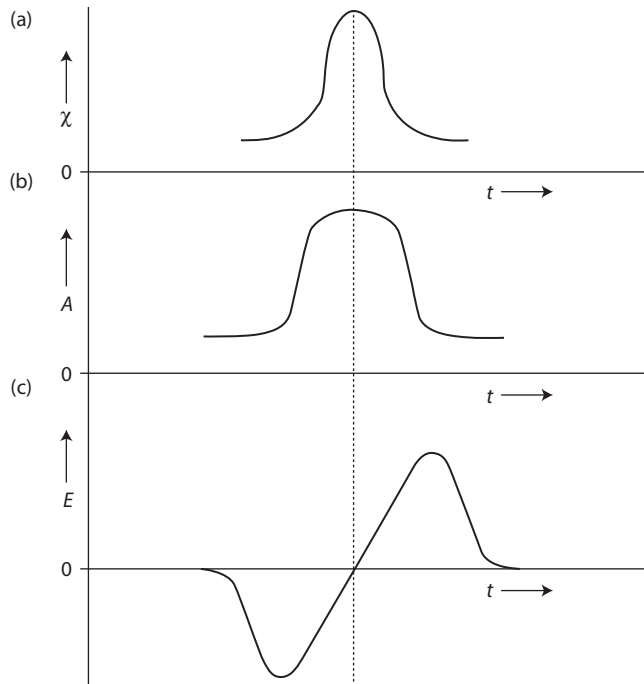


FIGURE 6.6 Schematic illustration of a subtle energy pulse χ , which generates the magnetic vector potential pulse A shown in (b), which, in turn, generates the electric field E shown in (c) at some specific origin in the healer's physical body.

2 h to either an unimprinted device (Figure 6.8a) or to an imprinted device (Figure 6.8b) and then monitored for several subsequent days.² For the unimprinted device, the subsequent pH readings are erratic while, for the imprinted device, the pH readings monotonically vary over time and step in an orderly fashion from day to day. The readings were taken from ~9:00 AM to 11:00 AM every day and at the start of each day with the buffer calibration. Later, in a separate experiment, the pH electrode was placed in the test solution, which initially drives the pH downward to equilibrate with the solution (initial transient deleted).

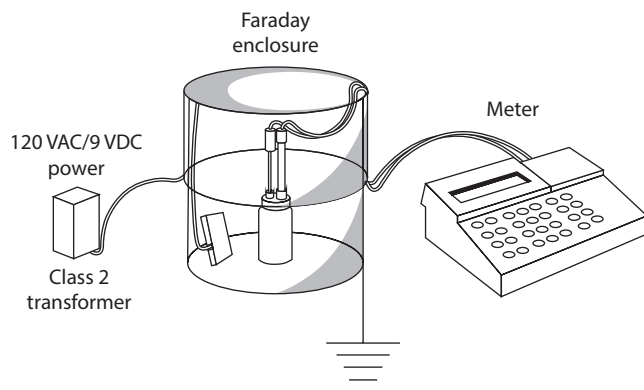


FIGURE 6.7 Schematic drawing of experimental setup used in simultaneous exposure to a device and pH plus temperature measurements.

Figure 6.9 demonstrates results with two different IIEDs, one with the intention to *decrease* the pH by one full unit (Figure 6.9a) and the other with the intention to *increase* the pH by one full pH unit (Figure 6.9b). The tests were made using different solutions so the equilibrium pH ranges were quite different. The purified water was ASTM type 1 (resistivity $\geq 18.2 \text{ M}\Omega \text{ cm}$, TOC $< 5 \text{ ppb}$) water, while the Castle Rock water is a naturally occurring spring water with total dissolved solids (TDS) of about 95 mg/L and $[\text{Ca}^{2+}]/[\text{Mg}^{2+}] = 2.0$. In these particular experiments, the pH change over ~5 days (7200 min) was ~ -0.5 pH units for the pH-decreasing IIED and $\sim +1$ pH units for the pH-increasing IIED, relative to the equilibrium pH range at 20–25°C for each experiment. When one uses a control device (unimprinted) instead of an IIED, the pH tends to stay in the equilibrium range or very close to it.

TARGET EXPERIMENTS 2 AND 3

To show the scope of this new potential technology, I briefly demonstrate its application in the area of biological materials (both inert and living) as well. Details, only of interest to biologists, are provided in Reference 2.

For target experiment 2, the specific IIED intention was to increase the *in vitro* thermodynamic activity of a specific liver enzyme, alkaline phosphatase (ALP). Four simultaneous, side-by-side variants were conducted on the same shelf in an incubator (held at 4°C) as shown in Figure 6.10. Comparisons could then be readily made between the control ALP solution (C) and

1. ALP solution placed in a small but otherwise empty grounded FC (F)
2. The same as (1) but with an activated *imprinted* device (d, j) present
3. The same as (1) but with an activated *unimprinted* device (d, o) present

The first comparison, (C) with (F), allows one to assess the effect of the broad band ambient EMFs in the incubator on the ALP activity. The second comparison, (F) with (d, o), allows one to assess the effect of low power (less than 1 μW) and specific frequency (three frequencies in the 1–10-MHz range) EMFs on ALP activity. The third comparison, (d, j) with (d, o), allows one to assess the effect of imprinted human intention, at constant EMF output, on ALP activity. In addition, simultaneous correlations between any and all of these different experimental states are available.

The results of this experiment, in terms of means with their standard deviations, are provided in Figure 6.11. The data were assessed via the ANOVA statistical procedure, and based on this, pairwise comparison with Tukey post hoc tests were examined. Visual inspection of Figure 6.11 and the ANOVA indicated that both the treatment and the dilution significantly modified ALP activity. The treatment rankings

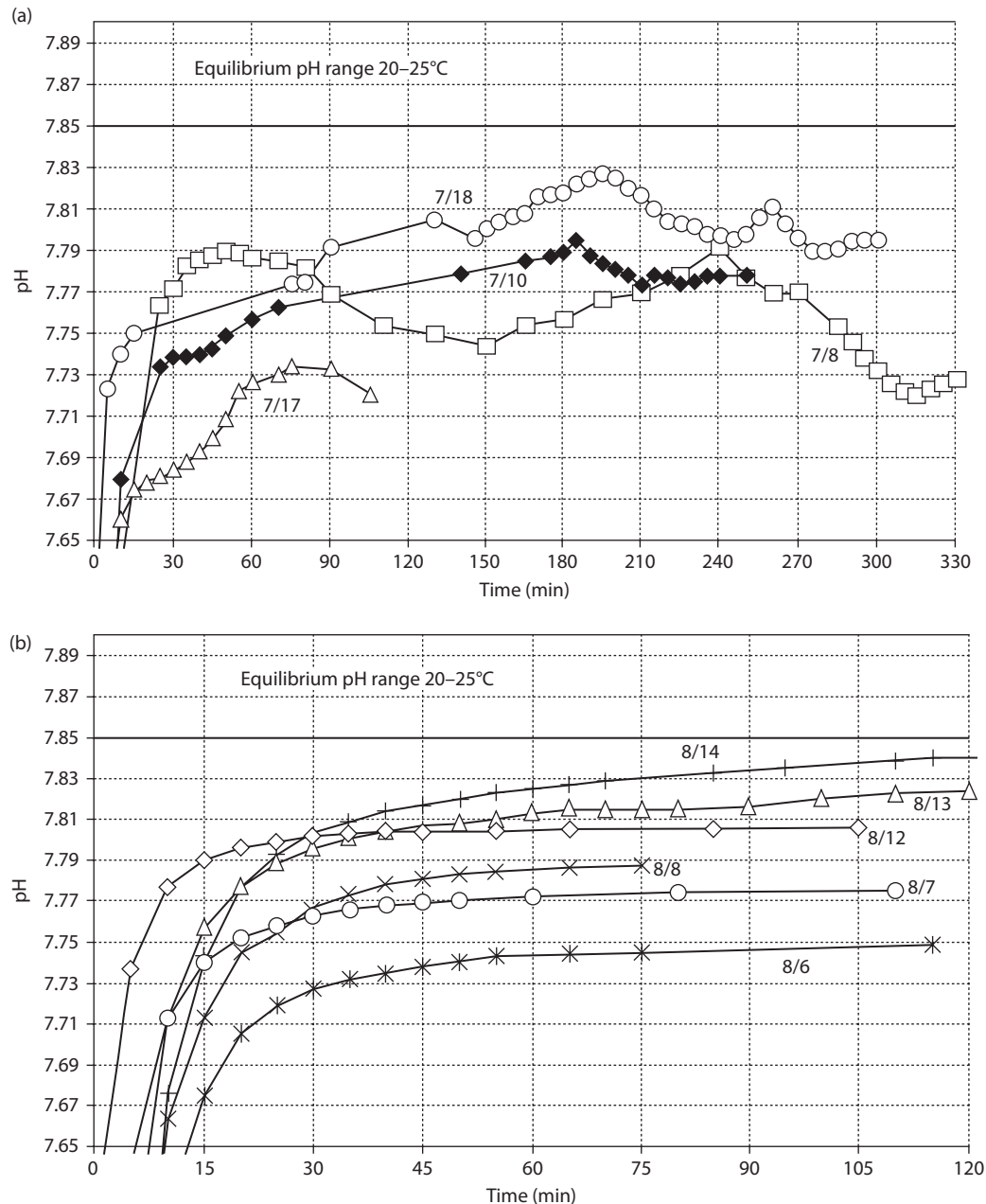


FIGURE 6.8 pH versus time for 50/50 dilution of Castle Rock Water with purified H₂O. (a) Measurements were made on a solution that had been exposed to an *unimprinted* three-oscillator device on July 7, 1997. Note irregular pH behavior and oscillation of pH in the 18 days following exposure. (b) Measurements were made on a solution that had been exposed to the *imprinted* three-oscillator device on August 5, 1997. Note monotonically increasing pH behavior and steady increase in pH in the days following exposure.

for both dilutions were $(d, j) > (F) > (C) > (d, o)$ and the Tukey post hoc comparisons between treatments indicated that

1. (d, j) was significantly ($p < 0.001$) greater than (d, o) and also significantly ($p < 0.005$) greater than (C)
2. (F) was significantly ($p < 0.011$) greater than (C)

For target experiment 3, the specific IIED intention was to increase the *in vivo* ratio of ATP to ADP in developing fruit fly (*Drosophila melanogaster*) larvae to significantly reduce

their development time to the adult fly stage. Once again, we incorporated four simultaneous experimental variants in a side-by-side positioning on a laboratory bench top (at 18°C and 55% relative humidity) as indicated in Figure 6.12. The four treatments investigated were as follows:

1. (C) : The control culture of 30 larvae (0–4 h old) transferred to a single vial containing nonstressful food
2. (F) : A similar culture inside an otherwise empty Faraday cage

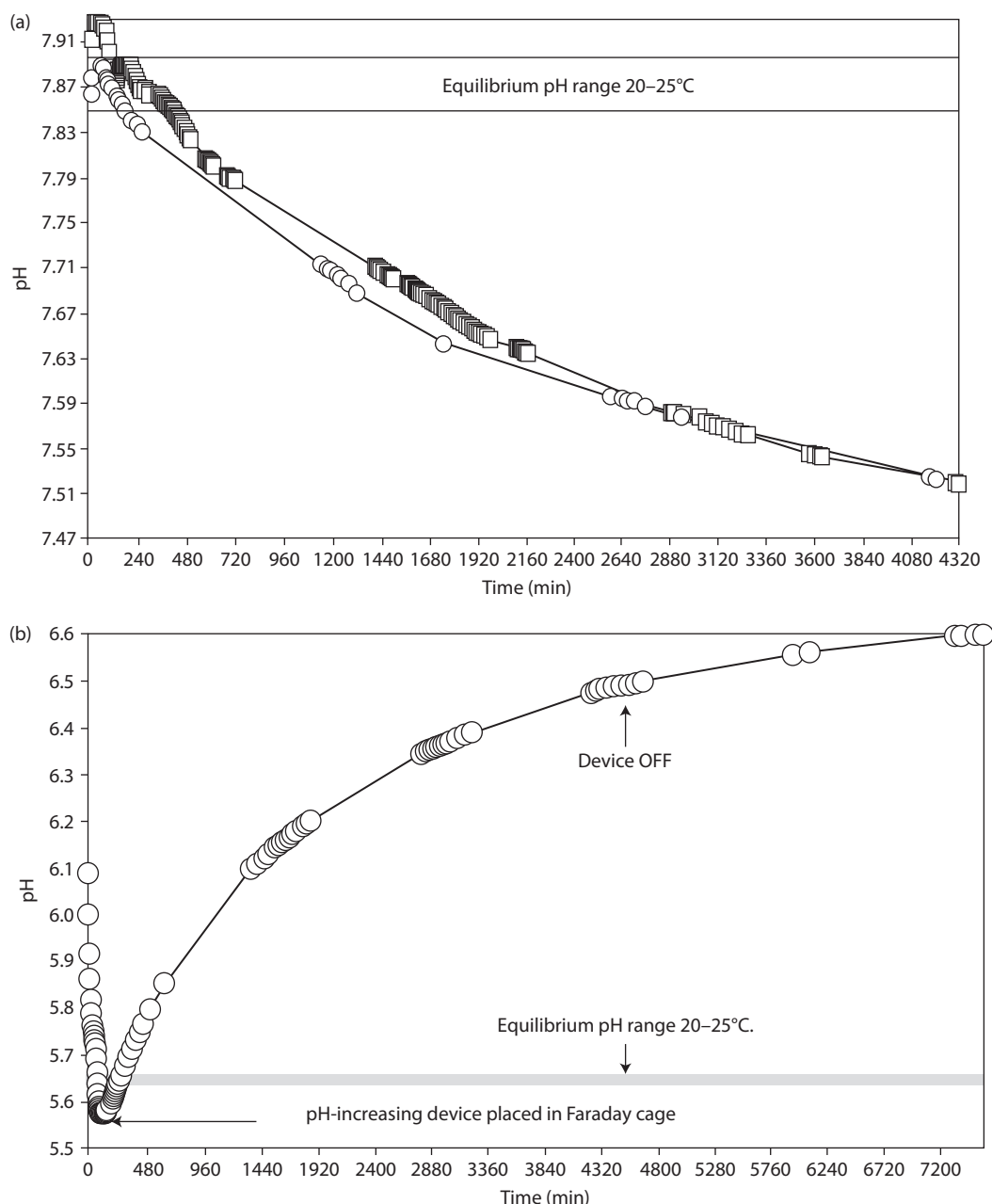


FIGURE 6.9 (a) pH versus time for 50/50 dilution of Castle Rock Water with purified H₂O. Measurement of pH was done simultaneously with exposure to the imprinted *pH-lowering* device for the data points depicted by square but only after exposure for the data points depicted by circles. (b) pH versus time of pure water in equilibrium with laboratory air during exposure to *pH-increasing* IIED.

3. (*d, o*): Culture as in (2) but containing an *unimprinted* device in the “on” state
4. (*d, j*): Culture as in (2) but containing an *imprinted* device in the “on” state

Our larval assay used high-performance liquid chromatography (HPLC) to measure changes in levels of ATP, ADP, and AMP present in larval homogenate samples. From this, the [ATP]/[ADP] ratio was readily determined. Larval development time (LDT) is defined as the time taken for half of the surviving adults to emerge. We assessed LDT and [ATP]/[ADP] ratio in a total study involving approximately 10,000

larvae and 7000 adult flies over an 8-month period.² For the [ATP]/[ADP] ratio assessment, we utilized a specific added amount of either nicotinamide adenine dinucleotide (NAD) or purified water to the larval homogenate samples for a set time period.

The experimental data is presented in Figure 6.13 as means with standard deviations arising from ANOVA statistical procedures and Tukey post hoc tests. For both results, the ANOVA gives $p < 0.001$ overall. In terms of our basic hypothesis concerning the influence of intention-augmented EMFs on larval fitness, this data provides robust support from LDT with (*d, j*) < (*d, o*) at the $p < 0.001$ level of statistical significance.